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THE SCIENCE AND PRACTICE OF SURGERY:

INCLUDING SPECIAL CHAPTERS BY DIFFERENT AUTHORS.

WITH NINE HUNDRED AND SIXTY-NINE ILLUSTRATIONS ON WOOD,
MOSTLY NEW AND ORIGINAL.

BY

FREDERICK JAMES GANT, F.R.C.S.

SENIOR SURGEON TO THE ROYAL FREE HOSPITAL;
AUTHOR OF "THE PRINCIPLES OF SURGERY: CLINICAL, MEDICAL, AND OPERATIVE."

SECOND EDITION, IN TWO VOLUMES,
REVISED OR RE-WRITTEN, AND MUCH ENLARGED THROUGHOUT.

VOL. II.

LONDON: BAILLIERE, TINDALL, AND COX.
PARIS: BAILLIÈRE. MADRID: BAILLY-BAILLIÈRE.
PHILADELPHIA: LINDSAY & BLAKISTON.
1878.

PRINTED AT THE CAXTON PRESS, BECCLES.

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THE
SCIENCE AND PRACTICE OF SURGERY.

CHAPTER XXXIX.*

EXCISIONAL SURGERY OF THE JOINTS AND BONES.

THE JOINTS, FOR DISEASE.

THE Operations of Surgery are generally of two kinds: those which consist in the *removal* of some part of the body, whether by Excision or Amputation; and those which effect the *restoration* of parts destroyed by disease or injury, or wanting by congenital defect, constituting Plastic Surgery. The latter class of Surgical Operations is responsive to the guiding principle of restoring the body to its healthy integrity of structure and function. So also, in the removal of any portion of the organism, similar considerations — anatomical and physiological—should ever be observed, with a view to the maintenance of that integrity as far as possible. But the removal of any part will be a resource in the hands of the true Surgeon only under *pathological* conditions justifying such interference, lest a surgical operation of unavoidable sacrifice become another name for reckless mutilation.

Taking the conditions, local and constitutional, which may be appropriate for the operations of Excision, in connection with their performance and after-treatment, we comprehend the full import of the expression "Excisional Surgery," as distinguished from a description merely of the operative procedures. Viewed in the latter sense only, Excision or Re-section, as it is sometimes less properly named, signifies the removal of any part of the body, by a cutting-out operation of extirpation. This kind of operation relates chiefly to the joints and bones, although it may be practised also for the removal of tumours, as adventitious growths produced in connection with the natural organism. With regard to the osseous system, comprising the joints and bones, excision may be practised either for disease or for injury of these parts.

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* Enlarged from the author's Lettsomian Lectures. Med. Soc., London, 1870-71.

In approaching this subject we may just take a retrospective glance at its history and time-honoured associations. Hippocrates, in whose writings 2400 years ago so many other surgical aspects of the present age are reflected, distinctly notices the re-section of bones at the joints,—as of the leg, the ankle, the forearm, the wrist. Then, again, we find Celsus and Paulus Ægineta both as explicitly directing the excision of the ends of bone,—the one in compound dislocations, the other in compound fractures with protrusion. But the latter writer refers also to the practice of excision for disease of the joints or of the bones: "When," says he, "the extremity of a bone near a joint is diseased it is to be sawn off: and often, if the whole of a bone, such as the ulna, radius, tibia, or the like, be diseased, it is to be taken out entire." Thus, then, Excisional Surgery had its origin in that fertile period of the world's history when arts and literature flourished. Subsequently, in the course of those dark and dreary middle ages, when the human mind lay dormant, as in a death, it is scarcely possible to trace a vestige of that which was destined to become a leading feature of modern surgery. Not until towards the close of the last century were the operations of joint-excision fully recognized. In 1781 Park, of the Liverpool Hospital, excised the knee-joint, and with a successful result. This was followed by a second successful operation on the knee, in 1789. Contemporaneously, in France, the Moreaus, senior and junior, practised excision of this joint, between the years 1786 and 1789; and then of the elbow-joint, the one Surgeon in 1794, the other in 1797. The efforts of Park and Moreau failed to make any, the slightest, impression on the profession or the public. In September, 1782, Park wrote to Percival Pott, of St. Bartholomew's Hospital, "a few sheets, in which," said he, "I hope to show that in some of the affections of the knee and elbow in which amputation has hitherto been deemed indispensably necessary, Surgery has yet another resource, which, as far as my reading and experience enable me to judge, has not yet been attempted by any other practitioner—I mean, *the total extirpation of the articulation.*" He emphasized his suggestion by underscoring it, as if printed in italics. This announcement, however, seemed in no way to have moved the original mind of the famous metropolitan Surgeon. On the Continent, the memoirs offered by the Moreaus to the French Academy provoked violent opposition, and were rejected with disdain by the surgical *savans* of France. Thus it was that towards the close of their labours the pioneers of Excisional Surgery experienced the mortification of knowing that they had attracted no followers—no successors.

It is unnecessary to pursue this general historical sketch further; those who revived the operations of excision, and subsequent contributors, will be amply noticed in connection with the consideration of the several joints.

Joint-Excision in relation to the General Treatment of Joint-Disease.—In the pathological history or course of inflammatory joint-affections, certain general indications of Treatment may be recognized, which, in the order of their conservative or preservative character, admit of the following arrangement; and whereby the *relative* bearing of Excision will become apparent.

The *Non*-operative indications comprise:—

(1.) Preservation of the Joint, functionally, by restoration of its mobility.

(2.) Preservation of the Joint, with loss of its mobility, by Anchylosis.

The *Operative* indications are :—

(3.) Preservation of the Limb, and Life, by sacrifice of the Joint, with Anchylosis, here more properly named Synostosis—*Excision.*

(4.) Preservation of the Life alone, by sacrifice of the Limb—Amputation.

The question of operative interference, it will thus be seen, can arise only when the joint-disease is already past the control of the first indication of treatment—restoration of the mobility and functional use of the joint; and when it has become subject to the second indication —preservation by anchylosis. But this result is also the object of Excision. The true comparison, therefore, of joint-excision for disease, is with the probability of *natural* cure by anchylosis. Such comparison should have reference, (1) to the joint, in respect to five essential particulars — the appropriate nature of the anchylosis or union, and the proper position of the limb for its functional use, the average duration of the periods of recovery, and the permanent character of that issue, with its average proportionate frequency; (2) the liability to life, or the comparative mortality of the natural cure by anchylosis and that resulting from excision, must also be considered. It may seem strange to speak of the mortality of the natural *cure*, for it might be said that, failing to obtain that issue in due time, the Surgeon would interfere by an operation, either of excision or amputation, before death ensues. But the period of natural cure is very protracted, extending often to five years or more, and even to ten years. Cases of this duration respectively—not, it must be confessed, of a very inviting and encouraging character—are recorded by Mr. T. Bryant and Mr. Hilton, as having occurred in their practice for the mechanical cure of knee-joint disease. But even a more important consideration is this—that such protracted recovery is attended with a proportionate reduction of constitutional vigour. Hence, with reference to the question of mortality, operative interference may be too late, or intercurrent disease, consequent on delay, may carry off the patient; in either case, death ensues from the prolonged attempt to bring about a natural anchylosis.

Statistical results, bearing on all these questions, and which shall be sufficiently accurate and comprehensive, are yet wanting to determine the relative value of the two modes of cure—nature *versus* excision. Meanwhile, the fair and reasonable course to take surgically, in any advancing case of inflammatory joint-disease, is this: to try to induce natural anchylosis by absolute rest and other proper treatment; and failing to obtain that issue, *timely* excision offers itself as a subsequent resource, under the conditions which are most favourable for a successful result to this operative procedure. What are they?

By an analysis of twenty carefully recorded typical cases, published in the "Medico-Chirurgical Transactions," 1870, I endeavoured to establish three propositions, representing the *conditions of disease* appropriate for excision of the joints in general; and certain supplementary propositions relating to particular joints. The experience of twenty-five *additional* cases enables me to confirm and enlarge these conclusions; and, so far as they may stand the test of yet further experience, they may be taken as *principles* or *rules* for the guidance of the Surgeon in his selection of this operation. I may here state that this series of cases is *consecutive—i.e.*, it comprises *all* the cases in which I have had recourse to the operation of joint-excision. No adequate basis for generalization can be afforded by any limited series of cases; but my own have the advantage of preconsidered observation and analysis, specially with a view to the purpose proposed; and the conclusions at which I arrived are verified, for the most part, and supported by large masses of evidence carefully gathered from recorded sources of trustworthy results.

GENERAL CONDITIONS OF DISEASED JOINTS APPROPRIATE FOR EXCISION. —*Functional inutility* of a Joint is the *resultant* condition for which the operation of Excision is appropriate; but as this may ensue either from persistent disease, or from failure of the natural cure, of a two-fold character, it includes three general conditions, proper for the operation:—

Firstly,—as the result of persistent disease—destruction of the articular cartilages, with perhaps dislocation, without the supervention of anchylosis; but whilst the *constitutional* condition has not advanced to hectic and emaciation.

Secondly,—as one result of the natural cure—Anchylosis, of a nature inappropriate to the functional use of the limb; being ligamentous where osseous union is required, namely, in the knee; or osseous where ligamentous connection is necessary, as in the hip or elbow, or any other joint except the knee.

Thirdly,—as another result of the natural cure—Anchylosis, with malposition of the limb. In the event of *fibrous* anchylosis, with malposition, mechanical extension of the limb, tenotomy, or both these resources may be tried prior to excision of the joint. *Osseous* anchylosis also, with malposition, may be subjected to certain operations of subcutaneous osteotomy; *e.g.*, in relation to the hip and knee joints.

Certain *subordinate* conditions, relative to the propriety of Joint-Excision for persistent disease, are less clearly established by an analysis of cases.

(1.) The comparative eligibility of chronic synovitis or of scrofulous caries would appear to be in favour of the former disease. Thus, in my knee-joint excisions, of 12 cases, the 3 which required secondary amputation were cases of scrofulous caries; of the remaining 9 cases, 6 were synovitis, and 3 scrofulous caries.

Professor Humphry's experience is somewhat different—at least with regard to the knee-joint—prolonged scrofulous suppuration of the thickened synovial membrane having been the most frequent cause of failure after excision, in his cases. ("Medico-Chirurgical Trans.," 1869.)

(2.) A limited extent of osseous disease would seem to be proportionately favourable for excision; but one or both articular surfaces, or *ends* of bone, may be diseased. The disease must not extend beyond the limits necessary for the formation of sufficiently wide osseous surfaces for an adequately secure union, osseous or ligamentous according to the functional use of the limb. Or the limits of diseased bone, with relation to excision, may have to be restricted for the preservation of a sufficient length of limb; and, consequently, for the preservation of the epiphyses or epiphysial cartilages, as affecting the subsequent growth of long bones, and thence of the limb. The epiphyses of the tibia and femur, in the knee-joint, for example, in relation to the growth in length of the lower limb, after excision of this joint.

(3.) Disease of the soft parts around the joint diseased is not, in itself, unfavourable to the result of excision; even although the integuments be much undermined by sinuses, and thickened by gelatinous infiltration, or soddened by puriform discharge. This surrounding condition of disease will subside, and the integuments regain a healthy state, when the central source of irritation, the diseased joint, is extirpated; provided only sufficient sound integument be left to cover the exposed ends of bone. But any considerable disorganization of the integument is generally connected with advanced constitutional disturbance and hectic exhaustion,—the most unfavourable condition for joint-excision.

(4.) A chronic state of disease, in the joint and surrounding soft parts, is a condition of far more favourable character for excision, than one of acute inflammation.

(5.) In all doubtful cases, as to the diseased condition of the joint, a good practical rule is, to lay the articulation open, by an incision as for the operation, and examine its condition, before having recourse to amputation, which can then be performed at once.

(6.) Certain co-existing constitutional diseases, as phthisis, seem to have an unfavourable influence, and in proportion to the progress of such disease.

(7.) Age has no special constitutional relation to the propriety of joint-excision. Either extreme period of life seems unfavourable for this kind of operation, owing to the long period of recovery; averaging three months at least for the knee or hip joint, and six weeks for the elbow-joint. As to extremes of age; taking the knee-joint as the best example of a large joint; according to Dr. R. Hodges, excision has been performed as early as three years, and as late as sixty-eight years. The former case recovered, with what state of after-limb is not recorded; the latter died. The average age of the fatal cases was twenty-five years; of recoveries, nineteen years. Of my own cases, the first, and one of the most successful, was thirty-three years old, and another, equally successful, was twenty-seven. But the constitutional power of recovery from severe compound fracture, after either of these periods of life, would suggest the propriety of trying excision of the knee-joint at a more advanced age. Thus, in one case, I performed this operation at fifty-three years of age,—the most advanced period of life, I believe, at which this joint has ever been excised; and complete osseous anchylosis resulted. *Youth* may be unfavourable for the operation of joint-excision, as being subject to an arrested growth of the limb, from removal of the epiphyses or epiphysial cartilages. But this objection refers only to excision of the knee-joint, the length of the arm, after operation at the elbow-joint, having a comparatively unimportant relation to its functional utility; and even with regard to the lower limb, the line of epiphysial cartilage may generally be left, thus providing to some extent for the subsequent growth of the limb in length.

OPERATION OF EXCISION.—Certain general directions are common to all these operations.

Instruments.—The requisite Instruments, and Apparatus for after-treatment, are few and of simple construction. They comprise scalpels, thin and stout-bladed, curved copper retractors, saws—a broad-bladed and straight-backed amputating saw, a long narrow-bladed saw, and Butcher's saw, the chain-saw; gouges, and cutting-pliers, the lion-forceps for grasping bone, torsion-forceps, suture-needles, and silk or silver wire; splints and bandages, or other retentive apparatus.

This list of armamentaria might be extended, and many and complicated instruments are described, particularly by French authors. It would, however, appear doubtful whether some such appliances can possibly be used in accordance with the design of Excision. Some, indeed, of the above-mentioned instruments are of restricted applicability, and come into use only occasionally. Thus, for the elbow-joint, the saw devised by Mr. Butcher has a narrow blade, and being movable, it can be adjusted at any angle; an advantage for running the saw easily, and in any direction, to finish off the excision. But, for the removal of an accessible slice of bone in the knee, the firm bearing of a broad-bladed amputating saw is preferable. The chain-saw also will be requisite only under quite exceptional circumstances; as to get round an imbedded bone, and which cannot be exposed and turned out as usual, as in some cases of hip-joint excision. Here, however, the long narrow-bladed saw is very handy, for removing the portion of bone *in situ*. I have seen the chain-saw used in excision of the hip, but not with any apparent advantage; and once the instrument broke. The "lion-forceps," devised by Sir William Fergusson, enables the operator to gain a firm grip of the off-portion of bone, in order to steady it for the efficient and free working of the saw. This instrument thus proves serviceable in completing the excision of any partially severed portion of bone.

Ligatures are scarcely ever necessary for the arrest of hæmorrhage; torsion will generally prove sufficient. I have never found it necessary to apply a single ligature in any joint-excision; nor subsequently, but once, on account of secondary hæmorrhage. Silver wire is, perhaps, preferable to silk for sutures; the latter material being, apparently, more apt to induce suppuration at the points of insertion along the line of incision.

(1.) The *incisions* should be formed so as to fairly expose the articular ends of bone. Hence, they vary in shape according to the particular joint; a single linear incision, |, as frequently practised for exposure of the elbow-joint or the shoulder-joint, or two such incisions, one on either side, for the wrist; a double rectangular incision, ⊣, as also applicable to the elbow-joint; or, as a ⊤-shaped incision, to the hip-joint; a curvilinear or elliptical incision, U, perhaps for the shoulder or the wrist, and certainly for the knee; or an H-shaped incision, as some Surgeons prefer for the latter joint; and modifications of these incisions for the ankle-joint. The incisions are so *placed* as to avoid important parts—tendons, blood-vessels, and nerves; and, therefore, not in the flexure of joints. The lines of incision which I am accustomed to practise, in the various operations of excision, as relating to the joints in both the upper and lower limbs, are here represented. (Fig. 478.)

(2.) The ends of bone should not be denuded of their *integument* or of their *periosteum*, to any extent beyond the line necessary for the osseous excision; the detachment of their vascular connection predisposing to necrosis.

(3.) The *extent of bone* to be removed must be determined by observing the appearances of disease, compared with healthy bone, as discovered during the operation of excision. Hence, this kind of operation may be a piecemeal proceeding; as, not unfrequently, in the elbow-joint. But the results of reparation, in the production of osseous thickening, spiculated or nodular enlargement, must not be confounded with the results of disease. In *growing* long bones—*i.e.*, in young persons, joint-excision should not extend beyond the epiphyses, or at least the epiphysial cartilages, in the ends of bone, on which the further longitudinal growth of bone, and thence of the limb, depends. The *sections* of bone should be parallel, so that the opposed osseous surfaces may be adjusted in apposition; a rule particularly important when osseous union is required, as in the knee.

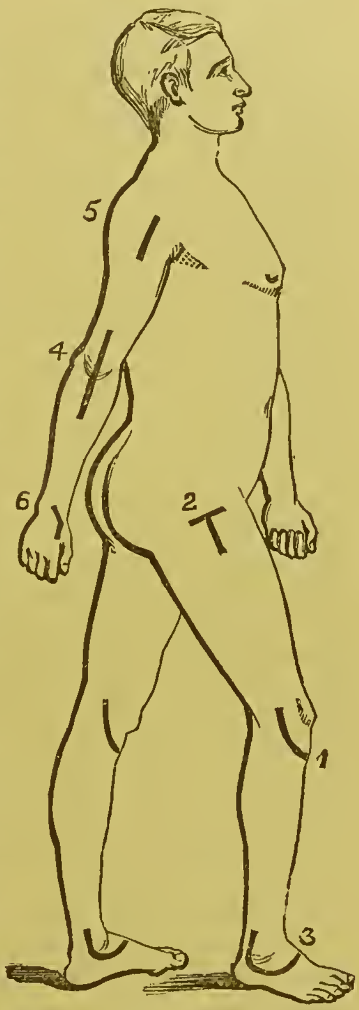
(4.) Skin and subjacent integument, exclusive of thickened synovial membrane, rarely need be removed; the soft parts recovering a healthy state, and protecting the ends of bone from exposure. Professor Spence lays stress on the necessity for removing *all* the diseased synovial membrane, or of destroying any inaccessible portion by cauterization, as with a solution of chloride of zinc (one part to thirty), perchloride of iron, or strong tincture of iodine. I have not yet had occasion to use any such application in any joint-excision.

(5.) *Hæmorrhage* may be arrested by torsion of the arterial vessels; ligature is rarely if ever requisite. Sponging with cold water will arrest any oozing hæmorrhage, and wash away any adherent particles of bone or clots.

(6.) The *ends of bone* must be placed in apposition, but not absolute contact; particularly when ligamentous union is required, as in the hip or elbow.

(7.) The *attitude of the limb* must have regard to its functional uses, after excision of the joint. Thus, in the lower extremity, the hip-joint and the knee should be straight, for support of the trunk and for progression. In the upper extremity, the elbow-joint should be semiflexed, to prevent osseous union, and to provide for the relative movements of the forearm and hand.

FIG. 478.*



(8) *Retentive appliances* should have regard to the necessity, or otherwise, for a *fixed* position of the limb, as the union required may be osseous or ligamentous. A suitable splint or splints and bandaging must be applied, so as to prevent the liability of movement in the directions of displacement peculiar to the joint, after excision; leaving the operation-wound accessible for dressing. This principle of treatment will be fully illustrated by the retentive appliances proper for each particular joint.

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* Figure showing Lines of Incision for Excision:—1. Of the Knee; 2. Hip; 3. Ankle; 4. Elbow; 5. Shoulder; 6. Wrist.

Finally, the *line of incision* is brought together and closed by sutures of silk or silver wire; care having been previously taken, at the very last, to see that any clot be washed out, and that the ends of bone are in apposition. Strips of lint soaked in water or weak carbolic lotion are applied to the wound, and overlaid by a large piece of oil-silk; a bandage being applied over all, to further exclude the air, and maintain some compression for a time, to prevent oozing secondary hæmorrhage.

The *After-treatment* of Joint-Excision is *local*, as relating to the process of union, integumentary, and between the ends of bone; and *constitutional* treatment, principally hygienic, as relating to the maintenance of reparative power; both aspects of the treatment having regard also to occasional complications.

(1.) Local after-treatment may be reduced to certain rules:—The integumentary wound undergoes more or less tumefaction, but it generally heals by the first intention—primary union taking place along the line of incision; except at its angles, which continue to discharge, slightly perhaps, a puriform matter or lymph, when the ends of bone have long since united. The *first dressing* need not be removed, usually for forty-eight hours; then the wound is to be cleansed, and similar dressing reapplied, the bandage being omitted, or applied lightly as inflammatory swelling supervenes. The *sutures*, some or all, may be allowed to remain for a week or ten days. The *retentive apparatus* should not be removed and reapplied for the first month or six weeks after excision, unless absolutely necessary to correct some important displacement of the ends of bone. If osseous union be required, this rule is the more imperative. The splints are reapplied at the end of another month, and so on; about three re-applications only being permitted in the course of osseous union, as of the knee-joint; while the splint may be abandoned at a more early period, and passive motion commenced, when ligamentous union is required, as in the elbow. A starched bandage may be substituted for splints, when osseous union has become sufficiently firm; and thus enable the patient to get about and regain his general health. *Secondary hæmorrhage*, a rare complication after joint-excision, can generally be arrested by the ice-bag, or irrigation, aided by the compression of a bandage; and I have only once had occasion to reopen the wound to secure a bleeding vessel—and that in the knee-joint.

Re-excision and *amputation* will severally be considered in speaking of the different joints.

(2.) Constitutional after-treatment should be equally free from the imputation of unnecessary interference. Guided by ordinary principles, little medicine-giving will be needed; the face gradually acquires a remarkable pallidity or sallowness, more than can be accounted for by the comparatively slight loss of blood in the operation; but this appearance wears off under the influence of quinine and iron, with a nourishing diet; the patient, supposing an excision in the lower limb, can often recline on a back-support in bed, so as to be enabled to read or write, or, if a female, amuse herself with needlework; and eventually, before leaving the bed, our patient has become the picture of health.

On the other hand, certain constitutional *complications* are apt to arise after excision, which are of an adverse, or even fatal, character. *Prolonged sickness*, from the influence of chloroform, may be subdued by the hypodermic injection of morphia, in one-sixth of a grain doses, while life is supported by nutritive enemata. *Painful jerkings* of the limb, especially in young hysterical subjects, or in consequence of the attrition of the osseous surfaces, is another untoward event, which may be subdued in like manner. *Acute inflammatory fever* may arise, almost immediately after excision, especially in young subjects; but this subsides or yields to ordinary treatment. *Pyæmia* I have never yet known to occur after joint-excision. Severe rigors and acceleration of pulse I have seen arise from attrition of the ends of bone, and in consequence of readjusting the splints, a month after excision of the knee-joint. But this paroxysm usually passes off. *Tetanus* has ensued in only one of my cases—a knee-joint excision in a young girl of sixteen, and with a fatal result; one of three deaths only I have yet had after any joint-excision. *Exhaustion*, in consequence of prolonged suppurative discharge, is apt to ensue in scrofulous patients; and this complication will probably lead to re-excision, or amputation instead, or afer the former resource has failed. Such cases of secondary amputation are often remarkably successful in saving life, albeit the limb is sacrificed.

Repair after Excision.—Joint-Excision may not be followed by any process of reparation, the ends of bone remaining ununited, as in ununited fracture. Reparation takes place more commonly, however; and the process consists in the production of a substitute-tissue between the ends of bone, forming an intermediate union; which may be either fibrous and flexible—as a ligamentous connection, or an osseous and immovable union. *Ligamentous* union is accompanied with an adaptation of the ends of bone to each other, forming a new joint; as after successful excision of the elbow, an instance of which will be described subsequently, from a case recorded by Mr. Syme. *Osseous* union would appear to result from a transformation of the fibrous tissue by a species of ossification; but associated with the production of true cartilage, in the form of nodules, which, as centres of development, also undergo ossification. How far the union may become, properly speaking, osseous, attaining to the minute structure of true bone, observations are wanting to determine. Any remaining portion of the original articular cartilage, after a partial excision, is not continuous with, but quite distinct from, the newly produced ossifying cartilage; and the former undergoes fatty and fibrous degeneration, thus losing its cartilaginous appearance. The muscular attachments, which had been severed by the osseous excision, probably regain new connections around the united ends of bone; the tendon of the quadriceps extensor muscle, for instance, acquires an insertion into the head of the tibia; while the soft parts around the joint become more or less thickened and indurated. Thus, then, the union is fortified, and the limb adapted to resume its functional use.

This description of the process of osseous union accords with what was found to have taken place after excision of the knee-joint, in one of my cases, which was, however, subjected to amputation in St. George's Hospital, ten months after the operation on the joint. The result is described as "repair after excision," in the Catalogue of the Hospital Museum; and also, in the "Path. Soc. Trans.," vol. xii. But the opportunities for such examination are necessarily few; in most cases, amputation of the limb is resorted to only when no appreciable reparation has commenced. The chief source of reparation is uncertain. Ollier's observations, with those of Maisonneuve, show the importance of the periosteum, as the most active organ in the formation of callus, after fracture, rather than the bone-tissue or even the medullary membrane, and as being far more productive than the surrounding texture. The same relative importance, therefore, may be attributed to the periosteum in the process of repair after excision. Accordingly, I always carefully avoid detaching this membrane, and its vascular continuity with the textures around the ends of bone, which should be left imbedded up to the surface of section.

Sub-periosteal Excision.—This method of excision has attracted attention by the investigations of Ollier respecting the ossific reproductive power of the periosteum. The operation essentially consists in detaching and reflecting the periosteal membrane, by means of variously contrived paring-elevators or other instruments; then the denuded portion of bone is sawn off; and, lastly, the membrane is replaced, that by its preservation the bone may be reproduced. This conservative procedure is applicable alike to the removal of the articular ends of bone in the excision of joints, and of the shafts of bones, partially or entirely. The periosteum is more or less readily detached; from healthy bone, and at an early period of life, this membrane can be separated easily, often being observed to curl back from a section of the bone in amputation; and in diseased conditions, as caries and necrosis, the membrane may be stripped off cleanly, or it slides off, having become detached; but in consequence of inflammation it may be found adherent, so as to be separated only with such injury as would destroy its vitality. The tendinous insertions of muscles are to be detached with the periosteum.

Two *advantages* result from this modification of excision, when successful. Firstly, the reproduction of substitute-bone, which may be required after removal of the articular ends of bone to an unusual extent in joint-excision, and which must be necessary after the excision of a more considerable portion in the shaft of a bone; thus, in either case, to regain as much as possible the original length of the limb. Hence the greater importance of sub-periosteal excision with regard to the knee or hip joint, than relative to the elbow or shoulder, the length of the arm being of less consequence to the functional utility of the limb. A second advantage of the operation is that any tendons detached with the periosteum may regain a better attachment than after ordinary excision. On the other hand, as affecting the joints alone, the sub-periosteal procedure would be *disadvantageous* where fibrous union and a movable joint are desired, as in the case of all the articulations, excepting the knee; unless, in other excisions, such an unusual length of bone be removed as would impair the use of the limb.

The *results* of sub-periosteal excision have not generally been successful, although there are notable instances of considerable reproduction of bone. This mode of operation has been practised chiefly by Ollier, Langenbeck, Dr. Sayre, and some other Surgeons in the excision of joints; principally the hip, shoulder, elbow, and knee. In nineteen cases of the elbow, collected by Ollier, there were four deaths, all, however, in adults; whereas in eleven cases under thirty years of age, all survived. As regards the mortality, therefore, no advantage can be claimed for this method, on behalf of the elbow-joint, compared with the ordinary mode of excision. Looking at the ultimate state of the joint, evidence is wanting to show any superiority; that the articular ends of the bone are reproduced, or greater range of motion obtained. Nor, as I have said, would the reproduction of bone in length add proportionately to the usefulness of the upper extremity; while ossific anchylosis would be positively disadvantageous. Respecting the shoulder-joint, in one remarkable case by Ollier, more than four inches of the shaft was removed with the head of the humerus; yet the ultimate shortening was only half an inch.

In the *shafts* of Bones, very successful results have been obtained; after sub-periosteal excision of the femoral shaft, to a large extent, by Mr. Joseph Bell, of Edinburgh; and in similar operation on the tibia, the whole diaphysis has been successfully removed by Dr. Cheever, of Boston, and by Letenneur, Larghi, and Crus y Manso.

Excision compared with Amputation.—The merits of excision in the treatment of diseases of the joints, are generally estimated by comparison with amputation of the limb, as if the two were *alternative* operations. Now, the incurability of joint-disease by non-operative treatment is indeed the condition eligible either for excision or for amputation. But in what does such incurability consist? The whole diversity of opinion and experience among Surgeons in regard to the propriety of excision *versus* amputation springs from a twofold view of the nature of the state in question. Thus, scrofulous disease of the knee-joint may be considered incurable, without operative interference, when the disease has advanced only to destruction of the articular cartilaginous surfaces of the tibia and femur without the supervention of anchylosis, so that the joint has become functionally useless; or, the same disease may not be regarded as incurable until it has advanced to a further and even to an extreme state of disorganization—dislocation (partial or complete), abscess, sinuses, profuse and long-continued discharge, with the constitutional disturbance of hectic and exhaustion. The turning-point of distinction between these two opposite states of the same disease is this: in the one case the joint has become functionally useless; in the other, to this condition is generally superadded a constitutional state of exhaustion which leaves no period of time nor vital reserve-power sufficient for any prolonged process of reparation after operation—averaging at least three months for the knee and hip, and six weeks for the elbow.

But this measure of time and of reserve-power are the essential elements of that reparative process which will inevitably be necessary to effect osseous or ligamentous union, as the case may be, and thence a successful result after *excision*. Consequently, compared with *amputation*, the operation of excision, under the adverse circumstances of *advanced* disease, will be singularly unsuccessful; whilst, at an *early period*, recourse to amputation is unnecessary and unjustifiable.

Excision and amputation for joint-disease are, therefore, *not* alternative operations for the Surgeon's choice of one or the other. The comparatively early period for excision is too early for amputation, and the comparatively late period for amputation is too late for excision. When either operation becomes justifiable for joint-disease, the other should not be entertained.

The *Natural Cure* by Anchylosis is the true standard of comparison for Joint-Excision, which, when successful, also results in Anchylosis;

and such comparison must have reference to the five essential particulars already mentioned (p. 3), and to the mortality.

The following *general results* of excision and their relation to conditions of disease of the joints, as illustrated by my own series of cases, may be here noted :—

(1.) *Excision* proved successful by one operation, in 21 out of 25 cases of the knee, hip, and elbow joints.

(2.) Of the 4 unsuccessful cases by one operation, 3 were cases of *scrofulous* disease, and of the knee-joint in a total of 12 cases; the remaining 1 being chronic synovitis, and of the elbow-joint in a total of 5 cases.

(3.) *Re-excision* was resorted to in 2 of the 4 cases; 1 knee-joint, and 1 elbow-joint, the latter with a successful result.

(4.) *Secondary amputation* in 3 of the 4 cases. All 3 were knee-joint cases, and subjects of scrofulous disease; 1 had been subjected to re-excision. The 3 amputations made *rapid recoveries*. These results tend to show that if the attempt to preserve a limb by previous excision, and even by re-excision of a large joint as the knee, should fail, the operation is not prejudicial to secondary amputation for the preservation of life.

(5.) *One death* only in the 25 cases, of the knee, hip, or elbow joints, whatever had been the condition of disease, subject to the principles of selection laid down; or whatever the operation—excision, re-excision, or secondary amputation. The fatal case was after excision of the knee-joint; and the cause of death—acute tetanus.

FIG. 479.*

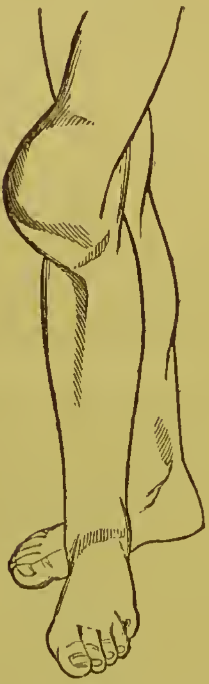
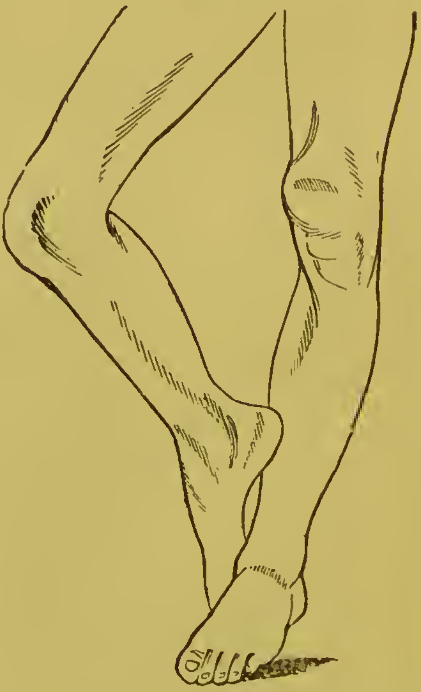


FIG. 480.†



SPECIAL EXCISIONAL SURGERY OF THE JOINTS FOR DISEASE.—THE

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* Royal Free Hospital. Case 12 in my series.

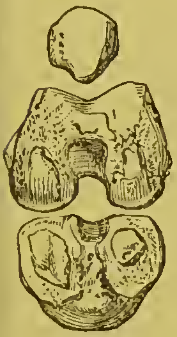
† Case 13, not included in the series. In these, and all the cases *before* and *after* excision of the knee-joint, the wood-engravings were drawn by Mr. C. D'Alton, from *photographs*.

KNEE-JOINT.—*The Conditions of Disease appropriate for Excision.*—The knee-joint, considered in relation to the operation of excision, illustrates the three general rules as to the conditions proper for operation :—Destruction of the articular cartilages, and perhaps dislocation (Fig. 479), without the supervention of anchylosis, but whilst the constitutional condition has not advanced to hectic and emaciation; anchylosis of a nature inappropriate to the functional use of the limb —namely, here, ligamentous union ; or such anchylosis, coupled with malposition of the limb (Fig. 480) by retraction and dislocation.

But there are also certain *peculiar* conditions as pertaining to the knee-joint which more especially determine the propriety of excision.

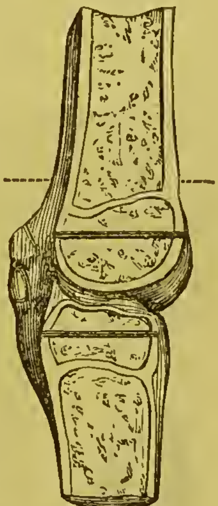
(1.) Compared with other joints, a certain *limit to the extent* of disease is essential to success. The disease must not extend in either the femur or the tibia beyond the limits requisite for the formation of sufficiently wide-based osseous surfaces to permanently support the weight of the body, and for the preservation of a sufficient length of limb to be really useful. (Fig. 481.) The *patella* should always be removed, as being diseased in some cases, and always useless as a remnant after excision of the joint.

FIG. 481.*



(2.) In *young* subjects — under the age of about ten or twelve years—it is of importance that the disease should not extend beyond the limits necessary for the preservation of the epiphyses or of the epiphysial cartilages (Fig. 482); the integrity of the latter, at least, being requisite for the subsequent growth of the bone, and thence of the limb, in length. The observations which led to this rule were originally made by Professor Humphry, of Cambridge.

FIG. 482.†



Operation.—Excision of the knee-joint for disease, originally introduced by Filkin, of Northwick, in 1762, was followed by Park, of Liverpool, as an independent originator, in 1781 ; but the operation, performed by Syme in 1829, and on the continent by Heyfelder in 1849, was revived by Sir William Fergusson in 1850, and followed immediately by Jones, of Jersey, and Mackenzie, of Edinburgh.

The patient lying recumbent, and under the influence of chloroform, the limb, already bent by retraction of the leg consequent on the joint disease, is firmly held by an assistant so as to present the knee vertically ; his one hand grasping the thigh, the other hand the leg, the foot of which rests on the table. The knee-joint is most conveniently laid open for excision by a curved horseshoe-shaped incision (U), extending from the side of one condyle downwards across the head of the tibia, just below its articular surface, to the same point on the side of the opposite condyle. Thus both ends of bone are exposed. A second sweep of the knife, dividing the ligamentum patellæ, will fairly enter the joint from side to side, when a touch or two over the remains of the crucial and lateral ligaments completely lays it open; the joint being at the same time forcibly flexed by the assistant. (Fig. 483.) In young subjects, with fibrous anchylosis, care must be taken to sever any such union with the knife, lest by forcible flexion either epiphysis become detached—an accident, in regard to the tibial epiphysis, which happened in one of my own cases, and which my friend Mr. Bloxam, of St. Bartholomew's Hospital, has seen occur in two more. The joint having been laid open, I raise the flap of integument with my left hand, hooking my fingers under the patella, and, taking particular care not to detach the integument from the femur, I draw the knife across just above the articular end of bone, so as to define it for excision. The saw, a small, broad-bladed one, is applied in this line, at a right angle to the bone, both vertically and transversely—observing to make allowance for the projecting direction of the articular end—upwards and forwards, in the flexed position of the limb, as held by the assistant. Unless this direction be observed, the section of bone will be oblique to the shaft. A few strokes with the saw brings its edge out just behind the condyles of the femur, and corresponding to the posterior margin of the articular surface of the tibia; when a slight jerk outwards of the blade detaches the section, exposing a broad, flat, osseous surface to the end of the femur. The popliteal vessels and nerves are quite out of the way in making this section, the saw inclining forwards towards the articular surface of the tibia, and the ligamentum posticum intervening. To make the tibial section, I apply the saw similarly in front of the head of the tibia, on the margin of the line of incision about half an inch below the articular surface, no detachment of the integument being necessary for this purpose, and carry the blade, at a right angle to the bone, or parallel to the articular surface, so as to bring the edge out about half an inch below it posteriorly; when a jerk upwards with the blade will detach the articular end without touching the ligamentum posticum, or endangering the popliteal vessels and nerves, and a broad, flat, osseous surface is exposed. Sometimes the "lion-forceps" (Fig. 484), is a useful instrument for the purpose of grasping firmly and holding steadily either articular section of the bone, when nearly detached by the

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* Royal Free Hospital. (Author.)

† Diagram, section of knee-joint in young subject; transverse lines showing the limits of excision through epiphysis of femur and of tibia.

FIG. 483.

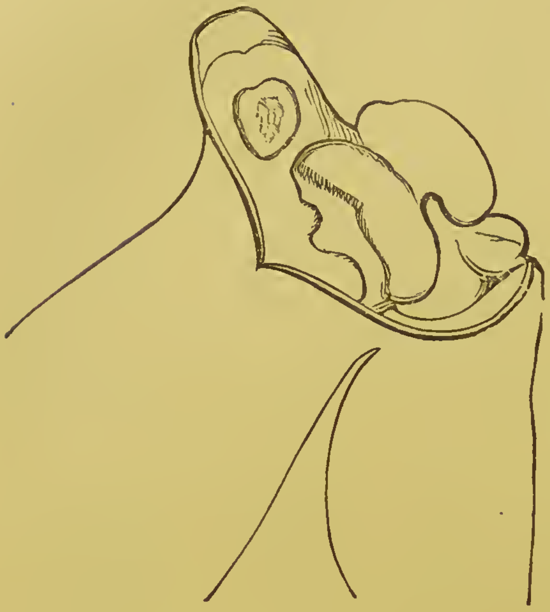
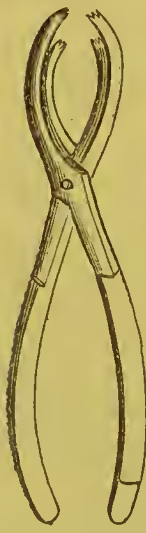


FIG. 484.



saw. And this instrument may be equally serviceable in other joint-excisions. If the tibial section were made from *behind* the articular surface, and the femoral section also, as some Surgeons practise the operation, the popliteal parts would indeed be quite out of the way; but the ends of bone are thus apt to be detached from their vascular connections, and the femoral section, as made from the front, is perfectly free from any risk, while the tibial section can be safely made with the little precaution already observed in using the saw towards the posterior ligament. But the liability of wounding the popliteal artery, either with the knife or the saw, should not be overlooked, that accident having happened in at least two instances, one of which was, however, a re-excision wherein the adjacent parts were somewhat affected by adhesion; yet, still to inculcate caution, this accident happened in the hands of a most skilful and practised operator. In the event of such a mishap, amputation must be performed forthwith. Excision of the joint may be performed in a *block*, instead of by separate section, when the articular ends of bone are firmly anchylosed; the piece of bone cut out having a V shape, owing to the projection of the knee forward from constant retraction of the leg.

The parallel surfaces of bone, thus made in either way, lie in parallel apposition when the limb is extended. This is the most important operative consideration with relation to the formation of firm osseous union. An oblique direction of either surface is most unfavourable to this result; too much space intervening at one part for the formation of an intermediate plate of bone, and the remainder of the surfaces being tightly locked, the limb cannot be flatly extended; painful startings of the limb ensue from attrition of the surfaces in contact, and no intermediate plate of bone can be produced. Thus, the union would be in part imperfect or ligamentous, and in part incomplete or wanting. A second section must be made from either end of bone, if necessary, to reach a healthy surface, or gouging may be requisite; but the extent of bone excised should be limited by the considerations already explained, and the surfaces must always be finished off *parallel*. The patella is then removed, avoiding the making of a button-hole in the integument. Any thickened synovial membrane, often slate-coloured, may be dissected out. I do not approve of its destruction by any caustic solution, as some Surgeons recommend. Hæmorrhage is easily arrested by torsion of the articular arteries, or any other small bleeding vessels. In scrofulous caries little difficulty is experienced. In chronic synovitis the bleeding is sometimes profuse, owing to the vascular and thickened state of the synovial membrane, and the bone remaining healthy and florid. But torsion, sponging with cold water, and exposure, will still prove sufficient to stop the hæmorrhage. It will be found injudicious to apply even a single ligature, which would thus leave a foreign body in the wound. I then extend the limb, and having seen that the ends of bone lie in even apposition—not absolute contact—a flat piece of sponge is held in the wound while the splints are applied. The extended limb is laid on a padded back-splint covered with oil-silk under the knee, this splint reaching from the fold of the nates to just above the heel. (Fig. 485.) The foot-piece forms part of the lateral splint, as thus the heel escapes pressure and a consequent tendency to sloughing. McIntyre's splint I have long disused; it not only causes some pressure on the heel, and precludes access to that part for dressing, if requisite, but the trough in which the limb lies induces more wasting of the muscles than would otherwise ensue, and thence also a loosening of the splint at an earlier period than when it may be safely removed for cleansing, and reapplied. Broad strips of adhesive plaster are drawn round the limb and splint, immediately above and below the knee, another broad strip high up on the thigh, and a narrow strip around the ankle. (Fig. 486.) A roller bandage is applied from the ankle upwards, and another high up from the thigh downwards, leaving the knee uncovered. An outside interrupted splint, well padded, and covered with oil-silk above and below the interruption at the knee, and provided with a vertical foot-piece, is now applied; this splint reaching from above the great trochanter downwards, and the end of the thigh-piece well supporting the very *end* of the femur externally, at the seat of excision, while the perpendicular foot-piece maintains the leg in position, and the upper end of the tibia in steady apposition with the femoral end of bone. Elevation of the whole limb five or six inches will be found to further aid the latter purpose. A short padded femoral splint may also be placed in front of the thigh, terminating just above the femoral end of the bone; but if the external thigh-piece be not *too wide*, this anterior splint will scarcely be necessary, and I rarely use it. The external splint is secured by a roller bandage from the foot to below the knee, and by another bandage from above the knee, up the thigh, and over the end of the splint, with two or three turns around the pelvis. The use of the external splint is to counteract the tendency to displacement of the lower end of the femur, in three directions, after excision of the knee-joint—projection outwards by abduction, rotation outwards, and projection forwards.

FIG. 485.

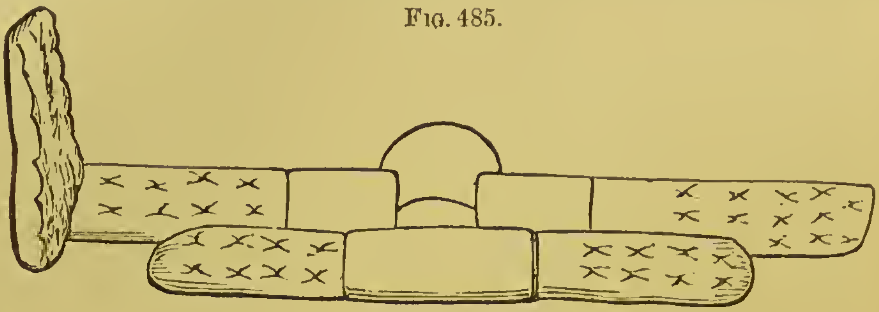
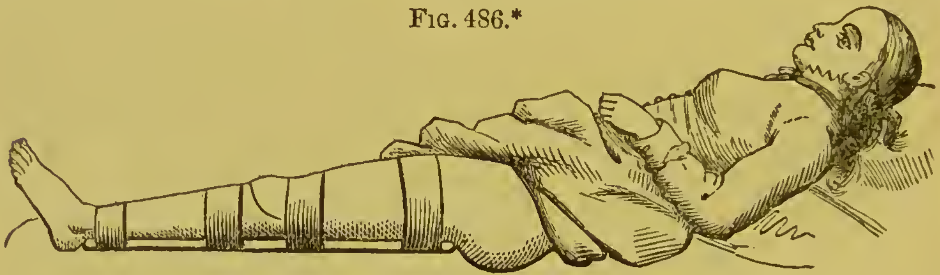


FIG. 486.*



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* Royal Free Hospital. (Author.)

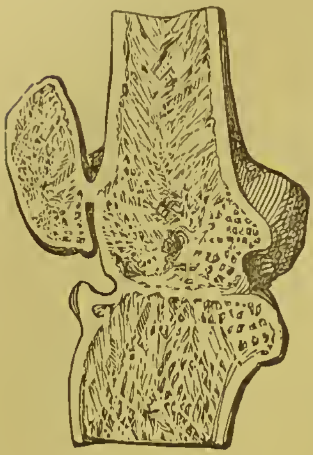
The first two displacements give the characteristic bow-legged and twisted appearance which, in a greater or less degree, is so common in the course of union after knee-joint excision, and both of which proceed apparently from muscular action; while the tendency to projection forwards seems to be produced by a constant sinking of the buttock in bed, thus tilting the lower end of the femur forwards. The side-splint specially counteracts all three displacements; the thigh-piece corresponding in length and breadth with the femur, any tendency outwards is prevented; while eversion and forward projection are restrained by the bandage, and the latter displacement by the support of a firm mattress, or at least a pillow under the buttock. I have had occasion to lengthen this side-splint up to the axilla, so as to counteract a tendency to an angular twist of the trunk to the opposite side in bed; whereby the lower end of the thigh is abducted, with an angular projection outwards at the knee. But there is no tendency to abutment inwards, and no occasion for the application of an internal splint, as practised by some Surgeons. Such a retentive appliance after knee-joint excision is the precaution of a blind timidity, not that which a due knowledge of the possible displacements would suggest.

Other forms of splint or retentive apparatus might be described, as that devised by the late Mr. Price, or the more recent one designed by Dr. P. H. Watson, of Edinburgh; but, without saying one word adverse to the employment of these or other splints, I have obtained results, by the use of my own splint, so entirely successful, and in so considerable a number of consecutive cases, as to leave nothing further to be desired.

Lastly, the sponge is removed from the excision wound, any clot wiped out, the ends of bone finally seen to be in apposition, and then the flap of integument closed down evenly by points of suture. Strips of lint soaked in carbolic acid lotion (one part to forty) are laid over the line of incision, and a broad piece of oil-silk over the whole knee; over all a roller bandage is applied to further exclude the air, and maintain some compression to prevent oozing and secondary hæmorrhage. The patient is removed to a bed close at hand, the limb elevated on pillows to a height of about six inches, and a cradle placed over the excision.

After-treatment should be conducted in accordance with the general principles common to all joint-excisions. But I would urge the importance, with reference to the after-treatment of knee-joint excision in particular, of one rule: not to reapply the splints before the end of a month or six weeks, unless absolutely necessary to correct some important displacement. At that time, having removed the splints and gently raised the limb, I sponge it with a spirit-wash, or with oil of turpentine, which both cleanses and fortifies the skin against the tendency to abrasion from pressure. This must be guarded against in reapplying the apparatus. And now the strips of plaster, if still necessary, may be applied *over* the bandage, around the back-splint; thereby preventing the irritation consequent on prolonged adhesion to the skin, and the pain caused in removing the plaster from the sensitive skin. At the end of another month's interval—the second month—on removing the splints, I gently test the progress of osseous union (Fig. 487), by placing my finger over the line of junction, and slightly moving the lower end of the leg up and down; the long leverage rendering any degree of movement at the union perceptible to the finger so placed, and even to the eye as a sort of hinge-motion. This test is far more delicate and painless than by grasping the limb above and below the knee, and moving it backwards and forwards; however gently that manipulation may be performed. At the end of the third month, on removing the splints, the trial of union may be made, by seeing whether the patient can himself raise the limb a little from the bed, by its own muscular action. If so, a starched bandage may be applied, provided with a back-splint and an external splint of pasteboard; and the limb being slung from the neck by a long loop of roller bandage, the patient may be allowed to get about on crutches to completely regain his general health. Apertures should be left in the starched bandage, opposite either end of the incision at the knee, where a small sinus-opening, at both points, often exists; and which may continue to weep for a considerable time. Don't probe these little openings. Any necrosed spiculum of bone will work its way out. Any subsequent displacement can be rectified before union is maturely consolidated; and the limb should be very gradually brought into use, for support and progression. The best mode of testing the weight-bearing strength of the union is that which I originally suggested. Let the Surgeon place his hand under the sole of the foot, while the patient, standing, gradually leans on the limb; a feeling of weight is thus communicated, which affords a far more accurate estimate than as indicated by the pressure apparently borne on the limb, when the patient is merely looked at in the same attitude.

FIG. 487.*



A high-heeled shoe or boot may be worn, to compensate for any shortening of the limb. I generally find it advisable to employ this substitute; at least, for some time after the operation, and where any considerable thickness of bone has been excised. But, in the cases of knee-joint excision by Professor Spence—eighteen cases (1871)—some obliquity of the pelvis was observed to compensate for the shortened state of the limb; whilst the movements of the hip and ankle joints supplied the loss of motion in the knee. An ordinary boot, therefore, was worn, similar to that on the healthy side; the patients thus walking better than with a high-heeled boot.

Results of Excision of the Knee-joint in relation to Natural Anchylosis.—The true comparison of joint-excision is with the natural cure by anchylosis. Such comparison would involve several essential particulars: the appropriate nature of the anchylosis, and with a proper position of the limb for its functional use; the duration of the period of recovery; the permanency of that result, and its frequency, as resulting from excision or from the natural cure; and their liability to life, or comparative mortality. Statistical results bearing on these questions, and which shall be sufficiently accurate and comprehensive for comparison, are wanting with regard to the knee-joint, no less than in respect to other joints.

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* St. Thomas's Hosp. Mus., D. 96^3. An excellent specimen of synostosis, with the femoral and tibial ends of bone in accurate apposition, after excision of the knee-joint. The patella, having been retained in this case, has also become firmly united to the end of the femur.

Six valuable cases of knee-joint anchylosis, resulting from disease, without suppuration, have been recorded by Mr. T. Bryant.* They do not, however, entirely meet the questions which I have suggested, and the limited number of cases do not supply sufficient data for comparison.

The period of natural cure would seem to be very protracted, extending often to five years or more, and even to ten years. Cases of this duration, respectively—not, it must be confessed, of a very inviting and encouraging character—are recorded by Mr. T. Bryant and by Mr. Hilton as having occurred in their practice for the mechanical cure of knee-joint disease. But even a more important consideration is this, that such protracted recovery is attended with a proportionate reduction of constitutional vigour. Hence, with reference to the question of mortality, operative interference may be too late, or intercurrent disease, consequent on delay, may carry off the patient. In either case, death ensues from the prolonged attempt to bring about a natural anchylosis. The patient is killed in the curing.

But this inquiry must be pursued. Its importance cannot be overestimated, since, even in the advanced state of suppuration, free incisions into the joint may prove successful in terminating the disease, with a movable joint, or at least with anchylosis—a mode of treatment in aid of the natural cure for which Surgery is indebted to Mr. Gay.

In a few instances which have come to my knowledge, *fibrous* anchylosis has occurred, as the result of excision of the knee-joint; and a false-joint having formed, instead of synostosis, the limb has become proportionately useful. One such case is related by Mr. Barwell,† the patient having been operated on by Mr. Cowell, at the Victoria Hospital.

Excision in relation to Life, or the Mortality after Operation.—Taking the results of large collections of cases, and those also in different Hospitals as smaller collections, three *general* conclusions may be established respecting the rate of mortality from knee-joint excision for disease:—1. A diminished mortality as the operation has continued to be practised. 2. Since the revival of the operation, and more recently, an average death-rate of one in four or five cases. 3. Very different death-rates in the hands of individual Surgeons, varying from one in two or three, to one in ten and one in nineteen, or even less. The conditions of disease, both local and constitutional, in the cases selected for operation, have doubtless mainly determined this different resulting mortality, and not uninfluential has been the mode of performing the operation, and more significant the after-treatment. But the operation and after-treatment in the particulars essential to success have, perhaps, chiefly affected the resulting state of the limb. The general results respecting the mortality of knee-joint excision for disease in large collections of cases, and those of different Hospitals in the United Kingdom during a period of five years, are exhibited in the following collections of cases, which illustrate the three general conclusions already referred to.

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* *Medical Times and Gazette*, 1870.

† "Trans. Clin. Soc." 1870.

For the special returns relating to Hospitals (and to individual Surgeons), I am indebted to those whose names are stated below.

It is scarcely necessary to observe that, of the large total number of cases, some are necessarily included in more than one collection.

1. Collected by Mr. Butcher. Period, 1850–54.—Number of cases, 31: recoveries, 25; deaths, 6 (mortality, 1 in 5). Period, 1854–56.—Number of cases, 50: recoveries, 41; deaths, 9 (mortality, 1 in 5 or 6).

2. Collected by Mr. Price. Period, 1760–1860, extended by Mr. H. Smith to 1865.—Number of cases, 316: recoveries, 240; deaths, 76 (mortality per cent., 24·05, or 1 in 4). Amputations after excision, 39: recoveries, 30; deaths, 9.

3. Collected by Dr. MacCormac.—Number of cases, 74: recoveries, 49; deaths, 25. Amputations after excision, 11: recoveries, 7; deaths, 4.

4. Collected by Mr. W. P. Swain.—Number of cases, 82: recoveries, 67; deaths, 15. Amputations after excision, 4: recoveries, 4; deaths, 0.

5. Collected by Dr. R. Hodges.—Number of cases, 208: recoveries, 106; deaths, 60 (mortality per cent., 28·84, or 1 in 3 or 4). Amputations after excision, 42: recoveries, 7 (?); deaths, 9.

6. Collected by Heyfelder.—Number of cases, 213: recoveries, 149; deaths, 64.

7. Collected by M. L. Peniere (British and foreign). Period, 1762–1869.—Number of cases, 431: recoveries, 300; deaths, 131, including 47 amputations and 6 re-excisions.

Author's Collection.

1. King's College Hospital; period, 1850–70. (Per Mr. H. Smith.)—Number of cases, 80: recoveries, 57; deaths, 23. Amputations after excision, 8: recoveries, 4; deaths, 4.

2. St. Bartholomew's Hospital; period, 1866–70. (Per Mr. Callender.)—Number of cases, 37: recoveries, 28; deaths, 9. Amputations after excision, 3: recoveries, 2; 1 death.

3. Royal Infirmary, Edinburgh; period, 1865–69. (Per Mr. P. H. Watson.)—Number of cases, 32: recoveries, 18; deaths, 14.

4. St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.)—Number of cases, 22: recoveries, 14; deaths, 4. There was one amputation after excision, which resulted in death. (Four cases under treatment.)

5. Royal Free Hospital, 1870.—Number of cases, 20: recoveries, 18; deaths, 2. Amputations after excision, 6, of which 3 were re-excisions: recoveries, 6.

6. Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per Mr. P. H. Watson.)—Number of cases, 18: recoveries, 16; deaths, 2.

7. Royal Sea-Bathing Infirmary, Margate; period, five years, 1870. (Per Mr. J. R. Clouting.)—Number of cases, 13: recoveries, 10; deaths, 2; re-excisions, 2, no improvement. In 1 case, result not stated.

8. Charing Cross Hospital; period, 1870. (Per Mr. Hancock.)—Number of cases, 11: recoveries, 11 (?).

9. Royal Infirmary, Liverpool; period, five years, 1870. (Per Mr. W. J. Cleaver.)—Number of cases, 11: recoveries, 10; 1 death. Amputations after excision, 3: recoveries, 3.

10. Westminster Hospital; period, five years, 1870. (Per Mr. F. Mason.)—Number of cases, 10: recoveries, 8; deaths, 2. There was one amputation after excision, which recovered.

11. London Hospital; period, five years, 1870. (Per Mr. M'Carthy.)—Number of cases, 8: recoveries, 5; deaths, 2; 1 progressing favourably.

12. Royal Albert Hospital, Devonport; period, five years, 1870. (Per Mr. W. P. Swain.)—Number of cases, 6: recoveries, 6. One amputation after excision, ending fatally.

13. Great Northern Hospital; period, five years, 1870. (Per Mr. J. Willis.)—Number of cases, 4: recoveries, 2; deaths, 2.

14. St. Mary's Hospital; period, five years, 1870. (Per Mr. Gascoyen.)—Number of cases, 2: 1 recovery; 1 death.

15. Guy's Hospital; period, 1864–69, or five years. (Per Mr. T. Bryant, from Dr. Steel, Superintendent.)—Amputations after excision, 4: recoveries, 3; 1 death.

Comparative Mortality of Excision, and Amputation in the Thigh.—The results of thigh-amputation for disease, as noted in University College Hospital, are thus stated by Mr. Erichsen: of 34 cases of such amputation, 7 died; or say 1 in 5—a mortality of 20½ per cent. Malgaigne's statistics from the Parisian Hospitals show a far higher mortality: in 153 cases of thigh-amputation for disease, 92 died, being a mortality of 60 per cent. Mr. Syme represents the mortality as yet higher—from 70 to 80 per cent., taking amputations of the thigh generally. Approaching larger masses of results, we find that in Mr. T. Bryant's collection of 1168 cases of thigh-amputation, 254 died, or 21·7 per cent.; and in Carrick's still larger eollection of 1413 cases, 434 died—a mortality of 30·71 per cent., or 9 per cent. higher mortality than in the former series. These large collections of cases, however, are indiscriminate. They include excisions for injury as well as for disease, and the latter not exclusively such as might be eligible for excision. But Mr. Bryant has supplied 188 cases of amputation of the thigh for chronic disease of the knee-joint; and of these there were 41 deaths—1 death in between 4 and 5 cases, or a mortality of 21·8 per cent. This nearly corresponds to the death-rate first stated; and it about equals the death-rate after excision. But if the mortality of thigh-amputation, and of excision of the knee-joint, both for disease of the joint, be thus about equal, the patients who survive either operation have a very different advantage; the one being without a limb, the other with the limb preserved!

State of the Limb.—The functional result of excision, whether of the knee-joint or other joints, is generally expressed in rather vague terms—*e.g.*, useful limb, without specifying the kind of union, or the position of the limb, as straight or bent. This indefinite mode of record omits much satisfactory information respecting the state of the limb after operation. As a specimen of the average record of results under this head, I may cite from Mr. Butcher's collection of cases referred to in considering the relation of knee-joint excision to the mortality after operation. Of the 25 recoveries, out of 31 cases, 17 were enabled to walk about with "perfect use" of the limb. Of the 41 recoveries, out of 50 cases, 33 had "useful limbs," the remaining 7 being subjected to amputation.

Compared with the stump after amputation, Sir William Fergusson justly observes:—"A well-healed stump never in reality improves, unless, possibly, it gets more callous, whilst often it gets more tender and irritable; but the seeming perfect result of excision at the end of six or twelve months, just when stumps are generally at the best, is no criterion of true perfection. If the limb is properly managed afterwards, it goes on improving for months—ay, for years. The thigh, leg, and foot enlarge in bulk; and in particular, with this change, the leg and foot improve in muscular energy." But why draw any further comparison between a stump—a truncated limb, and a slightly shortened limb, even although the stump be fitted and set off with an artificial leg?

The *average duration* of the progress of recovery is considerable. According to Dr. Hodges' tables, the duration of treatment, when the patella had been removed, in 48 cases, was 225 days; and when that bone is believed to have been left, in 38 cases, this period extended to 255 days. The average duration, therefore, was about eight months.

But in eight successful cases, all of them children, at St. Thomas's Hospital, the average duration of treatment, as reported by Mr. Allingham, was only 206 days, or about seven months. Many cases also progress more rapidly than this; and in my first case of excision of the knee the period of osseous union was only sixty days, or two months, the knee then supporting the weight of the trunk. This patient was thirty-three years old at the time of operation, with previous synovial disease of six years' duration; and the union has stood the test of nineteen years' free use of the limb (1878). The *average* period for recovery, in my own cases, has been, for the production of firm or perhaps osseous union, three months; and to regain a thoroughly useful limb, three months more, in a starched bandage, with gentle use of the limb gradually, for support and progression. Subsequently the limb will regain bulk and strength by increasing muscular development.

The *permanent* character of a successful result after excision, and the *average frequency* of such result, are questions severally omitted from statistical records. Both these important elements are noted in the results of my own cases. (See *Analysis*, p. 29.)

The *growth of the limb* in length, after excision of the knee-joint, is a question respecting which the results are conflicting. The question can only affect the propriety of this operation in *youth* or *childhood.* It was originally suggested and investigated by Professor Humphry, of Cambridge, in an admirable paper on the Growth of Bones in their Long Axis at their Epiphysial Cartilages. The two epiphyses—upper and lower—in a long bone are not equally productive of its longitudinal growth; one is a more active organ of growth than the other. In the tibia and humerus the upper epiphysis is thus more important; in the femur and radius, the lower epiphysis. But the lower femoral epiphysis would appear to be *relatively* more important to the longitudinal growth of the femur than the upper tibial epiphysis is to the elongation of the tibia. Hence, with reference to excision of the knee-joint, removal of the *femoral* epiphysis will more especially arrest the subsequent growth of the limb in length. The growth of the *foot* also is arrested, so that it may become insufficient to sustain the weight of the body. All this arrest of development may be reduced still further by the imperfect growth from previous disease.

The practical deduction, therefore, seemed to be, that if, by excision of the knee in a growing subject, the epiphyses and epiphysial cartilages of the tibia and femur be removed, this operation will *invariably* tend to arrest the growth of the limb subsequently. Mr. Pemberton, of Birmingham, followed in 1859 with a case in which, a youth having been operated on in 1854, the limb in 1859 was nine inches shorter than its fellow. Another case, from the practice of Dr. Keith, of Aberdeen, showed a deficiency in length of five inches during six years' growth. Counter-evidence on this question is adduced by Mr. Butcher. Dr. Keith himself wrote to the latter eminent Surgeon, in 1856, that "J. Hay's limb, operated on November, 1853, is plump, and growing in length as fast as his sound limb. So also is J. Keith's, operated on May, 1854." Corroborative cases are cited from reports by Mr. Page, of Carlisle, and Mr. Brotherston. In a case where the entire epiphyses were removed by Mr. C. Heath from the knee-joint of a boy aged eleven years and a half, subsequent measurements showed that the *loss* of growth in length of the limb, was only two inches in five years and a half. This case also illustrated the fact that such arrest of growth depends more on the removal of the lower epiphysis of the femur than the upper epiphysis of the tibia, the one bone growing in length less than the other after removal of its epiphysis at the knee-joint. Thus, the femur, as compared with its fellow, had lost four inches; the tibia, compared with its fellow, had lost only half an inch,—making an absolute difference in the whole length of the limb of four inches and a half.

The permanent *utility* of the limb thus shortened by arrested growth, may not be impaired. After an excision of the knee-joint by Mr. Holmes, eight years previously, and where the whole epiphysis of the femur was removed, progressive shortening had taken place to the extent of six and a half inches, by twenty-two years of age; yet a compensatory dropping of the pelvis on that side to the amount of two inches, and a high-heeled boot of four inches, enabled the patient to walk with a slight limp to any distance, at the rate of over four miles an hour; and he can walk twenty-five miles a day without fatigue. The muscles of the thigh are much wasted.

Still, allowing for these and other exceptional cases, the rule already laid down as to excision of the knee-joint in young subjects, under the age of about ten or twelve years, should be observed.

Re-excision.—This proceeding is particularly advocated by Sir William Fergusson. In his "Lectures on the Progress of Surgery" he urges re-excision after a fair trial of the result of the original operation. Then he observes: "I believe dealing freely with the wound, opening sinuses, clearing away strumous effete material, picking away loose necrosed pieces of bone, gouging away bare material of the kind —ay, even opening up the whole surfaces, and sawing off fresh pieces of bone, to be better than amputation." My own experience of re-excision, as to the knee-joint, has been favourable. Thus, in 12 cases of knee-joint excision, 1 was followed by re-excision, and then by secondary amputation, but with a recovery so rapid as seemed to indicate that neither of the previous operations, excision or re-excision, was prejudicial to secondary amputation for the preservation of life.

Secondary Amputation.—In exceptional cases, the course of an excision of the knee-joint may look very unpromising, so that the Surgeon may be tempted to despair of a successful result, and exchange a watchful after-treatment by resorting at once to amputation. It would be impossible to give directions which should supersede judgment in all the contingencies which may arise. So long as any failure of osseous union may be referable to a limited amount of caries or necrosis and suppuration, at the seat of operation, the case will be one for topical interference, or, at the most, timely re-excision. Even under the most unfavourable circumstances apparently, experience has justified me in not hastily dooming a limb to (secondary) amputation. Thus, in one case, where in addition to excision for unusually extensive scrofulous caries of both articular ends of bone in the knee-joint, it was also necessary to remove the whole of a thickened, pulpy synovial membrane, nothing but a very thin skin flap was left. This sloughed entirely, exposing the ends of bone; extensive necrosis seemed very probable, or osteo-myelitis, under these circumstances. Yet healthy granulations sprung up between the section-surfaces of the femur and tibia, in apposition, and the granulations coalescing, the breach of continuity was restored by fibrous union; at the same time cicatrization dipping down from the surrounding skin, completely closed the large opening. Eventually, the cicatrix became level, and movable; while ossific union slowly took place. The result was one of the best-looking and most successful excisions that could be desired.

The *probability* of amputation becoming necessary after knee-joint excision is a question that may be gathered from the collections of results which I have brought forward, and which show also the mortality, in *addition* to the proportion of deaths arising from the operation of excision. Of the 7 cases alluded to in Mr. Butcher's report as having been subjected to amputation after excision had apparently failed, 6 recovered rapidly, and only 1 died. In my own cases, of 12 knee-joint excisions, 3, including the 1 re-excision case, were submitted to amputation, and all made rapid recoveries. Compared with *primary* amputation of the thigh for disease of the knee-joint, these results as to the mortality are most gratifying, and without at once sacrificing the limb, which might yet be preserved by excision. Thus, in addition to the statistics already quoted, the mortality of primary amputation formerly at St. George's Hospital, as practised for "abscess" and "ulceration of the articular cartilages," was most melancholy. Of 11 such amputations of the thigh at that Hospital, as reported in the *Medical Times and Gazette* (1856), 5, or nearly 50 per cent., of the patients died, while 1 of the remaining 6 was convalescent only on the sixty-second day.

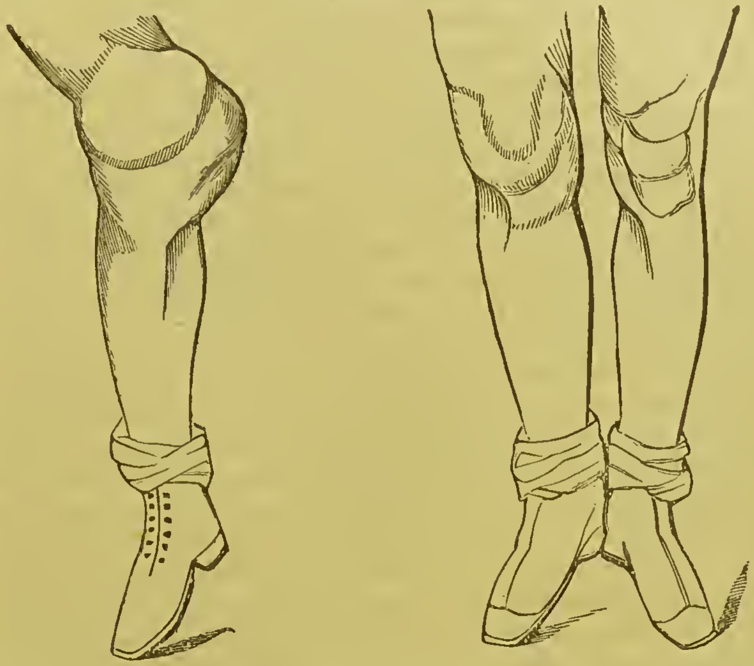
TYPICAL CASES OF KNEE-JOINT EXCISION.—In proceeding to record the essential particulars of some of my own knee-joint cases, it seems desirable to take them separately from the records of previous experience, in order to represent them from two points of view;—firstly, as supplying *typical* illustrations of the conditions of disease, local and constitutional, which are appropriate for excision, and the results, proximate and permanent, of operation in each case, together with any peculiarities; secondly, the cases are submitted to analysis with reference to these and other *questions* of importance pertaining to excision of the knee-joint for disease.

Two of the cases were partly narrated in the Hospital Reports of the *Lancet* of 1860; the remaining ten cases I have abridged from clinical notes carefully taken by Mr. T. C. Murphy, formerly senior house-surgeon at the Royal Free Hospital.

The first four cases especially illustrate the conditions of disease which are most suitable for excision of the knee-joint, during the course of disease; in three other cases, 7, 8, and 9, as from failure of the natural cure, both in regard to the kind of anchylosis and by malposition of the limb. The remaining five cases—belonging either to the former or to the latter class—are interesting more particularly as exhibiting peculiarities or complications: in one case, albuminuria; in another case, a very early period of life; in another, pregnancy at the time of excision, but safe parturition at the full period, with a living, healthy child, and the mother's limb having undergone firm osseous union; in another, accidental detachment of the tibial epiphysis in the operation; in another, acute tetanus and death.

CASE 1.—Elizabeth D——, æt. 33; admitted into the Royal Free Hospital on the 12th of September, 1859. *Chronic synovitis* of the right knee-joint, of traumatic origin (Fig. 488); duration of disease, six years; treatment occasionally. *Ulceration* of the articular cartilages, and extensive *caries* of the ends of the femur and tibia. Constitutional condition, nervous exhaustion. *Excision. Recovery*, with firm osseous union and a thoroughly useful limb, in two months. *Result* known to be permanent after nineteen years (1878). (See Fig. 488.)

Fig. 488.



Case 2.—William A——, æt. 27; admitted into the Hospital July, 1869. *Chronic synovitis* of the left knee, apparently of constitutional origin; five years' duration; four months' treatment. Pulpy thickening of synovial membrane. *Ulceration* of the articular cartilages, and superficial *caries* of the ends of the femur and tibia. Health good. *Excision. Recovery*, with firm osseous union and a useful limb, in three months. Subsequently, limb slightly bowed. *Permanent* result known, one and a half year.

Case 3.—John P——, æt. 18; admitted into the Hospital October 19th, 1859. *Scrofulous caries* of the ends of the femur and the tibia in the right knee-joint, of traumatic origin; five and a half years' duration; two years' treatment, in five Metropolitan Hospitals. *Partial ulceration* of the articular cartilages. Hectic and emaciation; this constitutional condition improved by medicine and diet before operation. *Excision. Recovery*, with union, in three months. At St. George's Hospital, apparent recurrence of the disease after ten months. *Amputation;* rapid recovery.

Case 4.—Emily R——, æt. 20; admitted into the Hospital April, 1869. *Scrofulous caries* of the ends of the femur and the tibia in the left knee, of traumatic origin; one year's duration; nine months' treatment. *Ulceration* of the articular cartilages. Health irregular. *Excision. Recovery*, with partly firm union, in three months. Formation of abscesses and sinuses around the callus, and prolonged discharge. *Amputation*, and recovery in a month.

Case 5.—Sarah A. H——, æt. 18; admitted into the Hospital

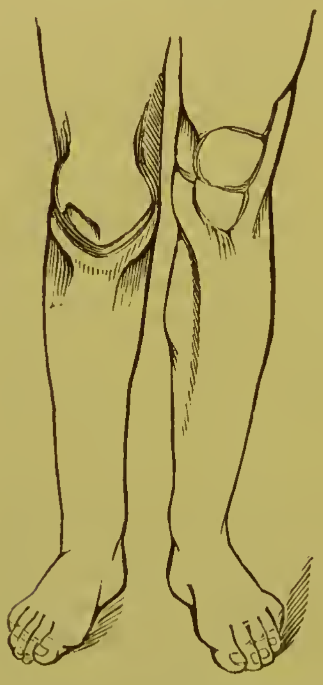
February 2nd, 1869. *Scrofulous caries* of the ends of the femur and tibia in the right knee-joint, of traumatic origin; twelve years' duration, with occasional treatment. *Ulceration* of the articular cartilages. Marked anæmia. *Excision. Secondary hæmorrhage* next day, suppressed by ice-bag. Displacement and projection of the end of the femur on the fifth day. *Re-excision* of its extremity. *Albuminous urine* supervened in a few days, with marked cachexia and prostration; and *sloughing* of the integument of the calf. *Amputation* in middle third of the thigh. Rapid disappearance of albumen in the urine, and restoration of strength. *Recovery* by primary union, with a perfectly sound stump, in one month. About six months afterwards, the stump was still sound, but the patient was affected with scrofulous conjunctivitis and opacity of the cornea, also complete deafness.

CASE 6.—Elizabeth A. G——, æt. 5; admitted into the Hospital July, 1869. *Scrofulous caries* of the ends of the femur and tibia, especially the latter, in the left knee-joint of a child, of supposed traumatic origin; three and a half years' duration, and occasional treatment. *Ulceration* of the articular cartilages. Health good. *Excision through the epiphyses. Recovery*, with firm osseous union and a useful limb, in four months. *Permanent* result known, one and a quarter year.

CASE 7.—Henry G——, æt. 20; admitted into the Hospital October 28th, 1869. *Chronic synovitis* of the left knee-joint, of traumatic origin; one year's duration; ten months' treatment. Partial ulceration of the articular cartilages of the femur and tibia, followed by partial *fibrous anchylosis* and retraction of the leg, with *partial dislocation* of the femur forwards. Health good. *Useless tenotomy* of the hamstring muscles. *Excision. Recovery*, with a thoroughly firm *osseous union* and useful limb, in two months and a half. *Permanent* result known, one year. (Fig. 489.)

CASE 8.—Henry H——, æt. 17; admitted into the Hospital November 27th, 1869. *Scrofulous caries* of the right knee-joint, of traumatic origin; fourteen years' duration, with occasional treatment. Partial ulceration of the articular cartilages of the femur and tibia, followed by partial *fibrous anchyosis* and retraction of the leg, with *partial dislocation* of the femur forwards. Health good. *Useless tenotomy* of the hamstring muscles. *Excision. Recovery*, with *osseous union* and a useful limb, in two months. This patient sat up out of bed daily at the end of five weeks. *Permanent* result. Nine months after operation (December, 1870) he could stand on the one leg unsupported, and hop on it; just before Christmas he walked from near Gray's Inn Road to Harrow and back—a distance of twenty-four miles—for a day's bird-snaring; and on Boxing-day he was sliding on the ice all day. Continued result, one and a quarter year after operation. (Fig. 490.)

FIG. 489.



CASE 9.—Thomas W——, æt. 10; admitted into the Hospital

October, 1869. *Scrofulous caries* of the left knee-joint, of traumatic origin; seven years' duration and equally prolonged treatment, latterly by *extension* of the limb. Partial ulceration of the articular cartilages of the femur and tibia, followed by partial *fibrous anchylosis* and retraction of the leg, with *partial dislocation* of the femur forwards. Health delicate, with constant cough. *Excision through the epiphyses. Recovery*, with *osseous union* and a useful limb, in two months and a half. *Permanent* result known, one and a quarter year. (Fig. 491.)

FIG. 490.

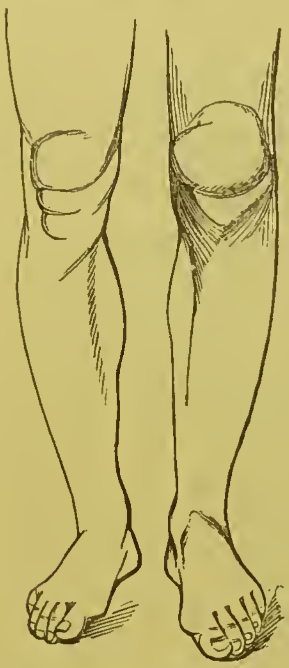
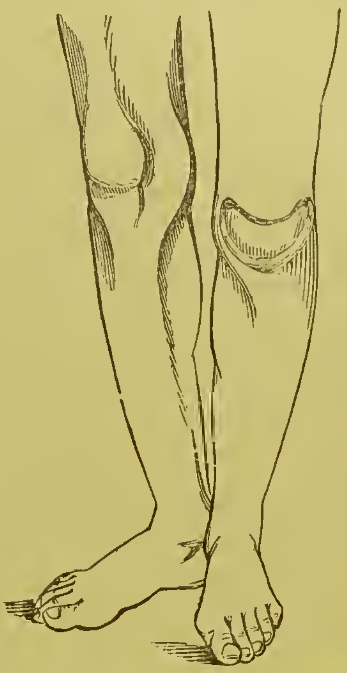


FIG 491.

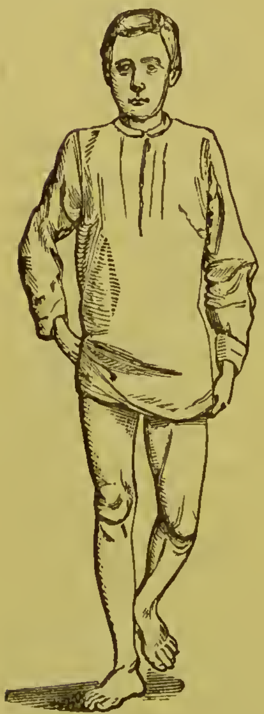


CASE 10.—Sarah S——, æt. 20. *Chronic synovitis* of the right knee-joint, of traumatic origin, by a fall off a form. *Duration* of disease, fourteen years. *Treatment* in two Metropolitan Hospitals at different periods up to fifteen years of age. At both these institutions amputation of the thigh was declared imperative. *Extensive ulceration* of the articular cartilages of the femur and tibia; limited fibrous anchylosis, with retraction of the leg to an angle of sixty degrees; anchylosis of the patella to the condyles of the femur. Health reduced; *pregnancy* of one month. *Excision.* The night of operation, sickness from chloroform. For two days, *painful startings* and jumpings in the leg of spasmodic character, affecting the knee. Fourth day, an hysterical fit, and the startings were renewed. The usual apparatus—a long back-splint, and an external interrupted splint with foot-piece—holds firmly, and no displacement of the ends of bone. Spasms subdued, and sleep induced by the hypodermic injection of morphia—one-sixth of a grain dose occasionally. Two months and one week after operation, "quickening" was first felt. The incision had firmly healed by primary union, and firm anchylosis between the ends of bone progressing. *Puffy swelling* around the knee; reduced by moderate and gradual compression with a many-tailed bandage. On removing the splints, a small *ulcer* was found on the *heel*, and another on the sharp edge of the *tibia*. Apparatus reapplied, leaving the heel

more uncovered, and an opening opposite the tibial ulcer. Under zinc-wash dressings, both sores healed. General health very good; the patient fast regaining flesh and colour, with a bright eye and cheerful aspect—looking, indeed, the picture of health. *Recovery*, with firm fibrous anchylosis, in three months; limb put up in a starched bandage, and the patient allowed to get about on crutches. Shortly after, was discharged from the Hospital. A tendency to bowing outwards of the knee was soon evinced; rectified by gradual manipulation, the imperfectly ossified callus admitting of such *re-adjustment*, and the starched bandage was re-applied. *Parturition* at the full period; the mother and child both having done well. Firm osseous union. *Permanent* result known, six months.

Case 11.—Harriet M——, æt. 16. *Chronic synovitis* of the left knee-joint, of traumatic origin,—by a fall, and many years afterwards, by a puncture-wound with a crotchet-needle two inches in depth, penetrating the joint. *Duration* of disease, thirteen years from first injury, six months from the second. *Treatment* commenced three years ago, continued for one year in a Metropolitan Hospital, then for some time in a special Hospital—where extension was long used without any permanent benefit. *Partial ulceration* of the articular cartilages of the femur and tibia; limited fibrous anchylosis, with retraction of the leg—the toes just touching the ground, and partial dislocation of the femur forwards. *Excision*. Sickness after chloroform. *Acute inflammatory fever* in twenty-four hours. Slight *rigors* on each of the two days following the operation. Third day, copious pink lithates deposit in urine, and subsidence of the fever. Sixth day, slight return of feverishness, and in the evening *erythematous patches* appeared on the arms, front of chest, and neck; face flushed. This subsided in twenty-four hours, under treatment by bicarbonate of potash and tincture of hyoscyamus. Eleventh day, a *gangrenous patch of skin*, about the size of half a crown, in the middle line of the incision, which sloughed away in two days, exposing a portion of the femoral end of bone. All the sutures were now removed. Wound otherwise healthy, primary union taking place except in middle, and, as usual, at the angles. Ends of bone in perfect apposition. Sixteenth day, trismus, followed by full development of tetanus in twenty-four hours. At the end of thirty-six hours, death. Hydrate of chloral had been tried in ten-grain doses every hour. P.-M. examination of the joint — Union by tags of lymph, puriform fluid around ends of bone.

Fig. 492.



Case 12.—William B——, æt. 9. *Chronic synovitis* of the left knee-joint, of traumatic origin, by a slight blow with a hoop. *Duration* of disease, ten months. *Treatment* in two Metropolitan Hospitals; and then in the Royal Free Hospital—by strapping, etc. Discharged; re-admitted in a month; *extension* by a back-splint and screw, continued for five weeks without any effect. *Partial ulceration* of the articular

cartilages of the femur and tibia; fibrous anchylosis, with retraction of the leg—the toes touching the ground, and partial dislocation of the femur forwards and outwards. *Excision.* Accidental *detachment of tibial epiphysis*, its removal, with the articular end of the femur *through* its epiphysis; also the patella. *Recovery* without a bad symptom. *Result*—Period since operation, seven years. (Fig. 492.)

ANALYSIS OF THE CASES.—(1.) *Conditions of Disease.*—Caries in all cases, with the destruction of the articular cartilages of both the femur and tibia. In Case 1 the femur was chiefly affected, in Case 6 the tibia, and in the other ten cases both bones were about equally affected. The patella was healthy in nearly all cases.

(2.) *Commencement of the Disease.*—Synovitis in six cases—1, 2, 7, 10, 11, 12; scrofulous caries in the other six cases. *Cause:* traumatic in eleven cases; constitutional in Case 2.

(3.) *Duration of Disease, and of Treatment previous to Operation.*—Case 1: disease 6 years; treatment occasionally. Case 2: disease 5 years; 4 months' treatment. Case 3: disease 5½ years; 2 years' treatment. Case 4: disease 1 year; 9 months' treatment. Case 5: disease 12 years; occasional treatment. Case 6: disease 3½ years; occasional treatment. Case 7: disease 1 year; 10 months' treatment. Case 8: disease 14 years; treatment occasionally. Case 9: disease 7 years; and equally prolonged treatment. Case 10: disease 14 years; treatment in two Metropolitan Hospitals. Case 11: disease 13 years; treatment 1 year in a Metropolitan Hospital, then in a special Hospital. Case 12: disease 10 months; treatment in two Metropolitan Hospitals, then in the Royal Free Hospital.

(4.) The constitutional disorder had *not* advanced to hectic and emaciation in any of the twelve cases except in Case 3. In Case 1, nervous exhaustion; 2, health good; 4, health irregular, digestion impaired; 5, marked anæmia; 6, health good; 7, health good; 8, health good; 9, health delicate, with constant cough; 10, health reduced; 11, health good; 12, health good.

Pregnancy. without miscarriage, at the time of excision; parturition at the full period, mother and child well; in Case 10.

(5.) *Age and Sex.*—Age: 33, 27, 18, 20, 18, 5, 20, 17, 10, 20, 16, and 9 years. Sex: six males and six females.

(6.) *Operation.*—The *incision* was semilunar downwards from condyle to condyle in all the cases. The *portions of bone* excised were the articular ends of the femur and tibia in all the cases, with additional portions of cancellated bone in Cases 1 and 6. The patella was removed in all cases. The *synovial membrane* was also removed as much as possible in Cases 2 and 7 of chronic synovitis. *Hæmorrhage* was inconsiderable during the operation in all the cases; no ligatures were required, the articular vessels being secured by torsion and exposure. *Sutures*—metallic in Case 1, silk in the subsequent eight cases. *Dressings*—water dressings in Cases 1 and 3, weak carbolic lotion in the other ten cases. *Splints*—a back-splint and an outside interrupted splint, with foot-piece, in all cases, except 1 and 3.

(7.) *Primary Union.*—Complete, except just at angles of the incision, in Cases 2, 6, 7, 8, 9, 10, 12, or in seven cases; partial in Cases 1, 3, 4, 5, 11, or in five cases.

Secondary hæmorrhage in Cases 3, 5, and 8; arrested by ice in the first case, by ligature in the latter two. Sloughing or ulceration from pressure in two cases, 5 and 10.

(8.) *Intervals of Removal of Splints.*—Average period one month after operation, and at similar periods subsequently; making only three or four reapplications of the retentive apparatus in each case.

(9.) *Results.*—Osseous or firm union, and a straight limb, in all the cases; except Case 3, where it was incomplete; Cases 4 and 5, which were subjected to amputation; and Case 11, the *only death*, and from acute tetanus in thirty-six hours, seventeen days after operation. Period of union, average three months. Afterwards the limb became slightly bowed in two cases—2 and 6; the latter a child aged five.

(10.) *Re-excision* in Case 5—a scrofulous case.

(11.) *Secondary Amputation* in Cases 4 and 5—both scrofulous cases; also in the questionable Case 3—a scrofulous case.

(12.) *Permanent Result.*—Ultimate known period: (1) 19 years; (2) 1½ year; (6) 1½ year; (7) 1 year; (8) 1¼ year; (9) 1¼ year; (10) 6 months; (12) 7 years.

In this series of typical cases for excision of the knee-joint, it should be observed that all of them relate either to scrofulous caries of the articular ends of bone, or to chronic synovitis, but not of a rheumatic character. The following case illustrates the condition of "chronic rheumatic arthritis," in which I had recourse to the operation; and at the most advanced period of life that excision has hitherto been practised,—*fifty-three years* of age. As being the only case of its kind, I have transcribed it almost in extenso from my original communication, and which is recorded in the "Medico-Chirurgical Transactions," vol. lvi.

Sarah A——, æt. 53, residing at Dunstable, was admitted into the Royal Free Hospital, July 25th, 1872. The history of her present state, as taken from the report of Dr. M'Kellar, senior resident medical officer, is briefly as follows:

Twenty-three years ago she had an attack of rheumatism, which, having affected various joints, finally settled in the left knee, giving rise to severe pain and considerable swelling, which confined her to bed for ten weeks. Recurring arthritic disease lasted up to December, 1871, a protracted period of twenty years. Then she had a fall from some height downstairs, the leg on the affected side being twisted under her. This injury immediately superinduced a worse attack in the knee-joint, and she remained in bed again for nine weeks. Treatment was adopted without affording relief, and at length she came to be under my care at the hospital.

On *admission* the left knee-joint was much enlarged, measuring in circumference two inches more than its fellow; it had a globular form, but presenting some irregular nodosities, apparently of an osseous character around the articular ends of bone; the joint had undergone partial dislocation backwards, the head of the tibia projecting behind the condyles of the femur, and false or fibrous anchylosis had taken place, giving some degree of immobility to the articulation, although this depended partly on a generally thickened state of the ligamentous and aponeurotic structures, and on the ossific deposit around the joint. Thence the subluxation became more conspicuous when the patient, a very corpulent woman, attempted to stand on the limb, whereby the condyles of the femur abutted more prominently forward, showing that the anchylosis was loose and flexible. The patella was firmly anchylosed to the femur just above the outer condyle.

Considering this useless state of the limb, excision of the joint seemed justifiable, with the view of inducing osseous union, and restoring a useful member. But the continued recurrence of severe attacks of pain, affecting the patient's general health, and the otherwise incurable character of the disease, more immediately determined the propriety of operation; while the prolonged duration of the joint-condition, the necessity for interference ere the patient's constitutional reserve-power might prove insufficient for recovery after operation, and the relatively advanced period of life, admitted of no further delay.

Accordingly I had recourse to excision, notwithstanding the patient's age.

After the operation no unfavourable symptom occurred of consequence. Primary union went on, except, as usual, at the angles of the wound, which gave issue to a moderate amount of oozing serous discharge; and in three weeks the line of incision had become soundly united. In the course of a week or two the patient was allowed, by her own request, to sit up in bed, reclining on a back support. *Seven weeks* after operation the splints were removed; firm union of the bones was found to be established, with the limb in a perfectly straight position. But the patient could not yet raise her leg from the bed. Apparatus reapplied.

October 4th.—The patient was carried from bed, and permitted to sit up for some hours, the limb in splints resting on two chairs. She was suddenly attacked with erysipelas, which, commencing in the foot and leg, spread up the thigh—sparing the front of the knee—and extended above the buttock to the loins, and round to the lower part of the abdomen. Eventually the limb remained in a state of great œdema.

During the course of this attack, the splints having been necessarily removed, the limb gradually became slightly bowed outwards at the knee, yet the union remained firm, and the incision never reopened or gave issue to any discharge. Oxide of zinc was powdered over the whole surface, forming a kind of casement which absorbed the moisture, and seemed to stimulate its internal absorption. The œdema subsequently yielded to bandaging, aided by the horizontal position of the limb. At length a starched bandage was applied, and about four months after operation the patient went home to Dunstable, with instructions to return for examination in about a month.

State of the limb five and a half months after operation.—Union firm and immovable. The bowed appearance at the knee is corrected. Measurements of the limb are as follows:—*Length* 32½ inches, sound limb 35½ inches, or 3 inches shortening as the result of excision; *circumference* of knee 15½ inches, of sound knee 14½ inches, or 1 inch more after excision; the calf 12½ inches, and at the same level of the calf in sound limb 13 inches, or only ½ inch less after operation; the thigh 19½ inches, and at the same level of the thigh in the sound limb, 12 inches, or 1½ inch less after operation. The functional use and power of the limb may be thus estimated at the period referred to: the use of the limb for support in progression is not yet perfect; but the patient can bear her heavy weight upon it, and can walk with the aid of a stick; the power of the limb, according to its muscular development compared with that of the other limb, is indicated by the circumferential measurements of the calf and thigh. As the limb is brought into more active use there cannot be a doubt that it will become even more nearly equal in respect to its size and strength.

Proceeding to comment upon the particulars of this case, some of them seem to be more especially suggestive.

First, the kind of disease submitted to excision was, I believe, almost entirely exceptional to previous experience. In the histories of a hundred cases collected by Mr. W. P. Swain, and which represent the majority of the cases operated on by Sir William Fergusson and some other Surgeons of experience, no allusion whatever is made to rheumatic affections, except in two instances. Of one of these cases (No. 84) the briefest description is given—that it was "rheumatic disease of the knee-joint," of no specified character; and that the result was recovery, but that of this case "no notes were taken." In the other case (No. 92) the patient had been attacked with "acute rheumatism" twenty years previously, but "she used the limb until eighteen months ago, when she fell, sprained and struck the knee, and since that the limb has been useless." The result of operation was recovery with a useful limb. In a series of thirty-nine cases of knee-joint excision by Professor Humphry, recorded in the "Transactions" of this Society (1869), in no instance was the "nature of the disease," as described, in any way connected with rheumatism. A similar exclusion prevails in twelve cases by Mr. H. Lee, as recorded in the same volume of "Transactions;" and also in the histories of thirty-one cases collected by Mr. Butcher, and in a second collection of fifty-one cases ("Operative and Conservative Surgery").

One case only of excision of the knee-joint has come to my knowledge, wherein the operation has been performed for chronic rheumatic arthritis; it was in the practice of Mr. Curling at the London Hospital, and the result was successful (*Lancet*, 1869).

Secondly, the age of the patient in my case is, I believe, the most advanced period of life at which excision of the knee-joint has hitherto been performed. In Mr. Curling's case the patient's age was only twenty-three years. From the various series of cases already referred to, I have gathered the most advanced ages at which the operation has been performed for other conditions of disease and the results.

It appears that excision of the knee-joint for disease, as performed in 13 cases between the ages of thirty-two and forty-seven years, has yielded 7 successful results; and that between the ages of forty-one and forty-seven years there were 11 cases, with 6 successful results. If then my own case, at the most advanced period of life, be superadded, we have a total of 12 cases, with 7 successful results, between the ages of forty-one and fifty-three years. With regard to the question of mortality: in one of the unsuccessful cases of excision, amputation afterwards was followed by recovery, thus making a gross total of 8 cases out of 12, or an average of 2 recoveries in every 3 cases; and if the accidental deaths by embolism on the eightieth day, and phthisis, be omitted, the recoveries rise to 8 in 10 cases, or 4 out of 5—a proportion fully equal to the successful results of amputation of the thigh for chronic disease of the knee-joint; with the advantage in favour of excision, that the limb is preserved.

Looking at all these cases of knee-joint excision for disease, two conclusions may be drawn: the one as to the extreme rarity of this operation for chronic rheumatic arthritis; the other, that the operation may possibly be performed with safety and advantage at a much later period of life than it has hitherto been commonly practised. The result of the case I have brought forward would more especially suggest an occasional extension of the operation, both in respect to the kind of disease and the period of life which may be appropriate, thus embracing a larger class of cases beyond those hitherto recognized as suitable for excision.

HIP-JOINT.—The *natural cure* of hip-joint disease has not yet been investigated in a series of cases, sufficiently accurate and comprehensive, for comparison with the results of excision. Such an inquiry should have regard, (1) to the joint, in respect to five essential particulars—the appropriate nature of the anchylosis, and the proper position of the limb for its functional use, the average duration of the period of recovery, and the permanent character of that issue, with its average frequency; (2) the liability to life or the mortality of the natural cure. It would be from these points of view, as to limb and life, that the results of excision must be compared and its relative value estimated. Pending this clinical inquiry, we may approach the question from our present knowledge of pathology.

What, then, are the changes which the joint and constitution undergo in the course of natural cure by anchylosis? In the joint there is a twofold process of destruction and reparation. A piecemeal or molecular excision, so to speak, is constantly progressing, apparently by absorption and certainly by the draining away of *débris* of bone in the discharge, until two healthy opposed surfaces are reached, so that union may at length be effected. This natural cure of joint-disease entails a protracted period of recovery, extending even to many years, as compared with that of weeks or months required for recovery after excision. During this ordeal the constitutional vigour is reduced, subsequently leaving the patient stamped with the aspect of suffering in former years. Occurring also, as it often does, during the growing period of life, the reserve-power, which should have been gained to meet the exigencies of after-life, is used up prematurely by incessant demand in the long process of reparative anchylosis. Persons who have undergone the natural cure of diseased hip-joint, for example, may be seen hobbling about the streets, being easily recognized by the characteristic gait of old-standing hip disease, and by their sallow and prematurely aged appearance. This constitutional decrepitude may possibly be averted by a remarkable acceleration of the excisional part of the process. In a case represented by specimen No. 7 of the hip-joint series, an eminent Surgeon differed with myself and others respecting its diagnosis; nature subsequently undertook the operation of excision *en masse*, for she severed and discharged the greater portion of the head of the femur through one of the fistulous tracks. This natural excision of a joint will be singularly suggestive to operative excisionists, and it should be equally admonitory to those Surgeons who blindly oppose the operation. Twenty-one cases have been collected by Dr. Hodges, in which spontaneous separation of the head of the femur having taken place, it was removed by operation, and with five fatal results.

The Conditions of Hip-joint Disease appropriate for Excision.—It was formerly held, and may still be maintained by some Surgeons, that Excision of the hip-joint for disease should be resorted to only in the following conditions—constitutional and local:—

(1.) Only in the last stage of the disease, or of constitutional endurance.

(2.) Only when the extent of disease is limited, the acetabulum being free from disease, and the amount of pelvic disease trivial.

(3.) Only when the head of the femur is dislocated.

The reverse of these rules or nearly so may be partly gathered from my cases, and can, I believe, be justified by accumulated experience, drawn from the results of a large but varying number of cases, with regard to each such rule in question.

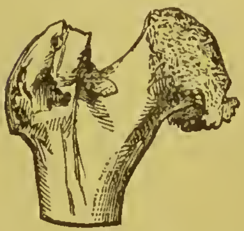
Of the three conditions laid down respecting Excision of the Joints in general, the first only applies to the hip-joint.

(1.) Destruction of the articular cartilages, without the supervention of anchylosis, will always justify operative interference by excision. The constitutional condition will probably *not* then have advanced to hectic and emaciation. But the state of the general health should primarily determine the necessity for excision in all cases, and not any arbitrary consideration of the period of the disease and the condition of the joint. Whenever, therefore, the general health is manifestly failing, whatever may be the stage of the hip-joint disease, excision should be resorted to and without further delay. This guiding rule was strongly urged and clearly illustrated by Mr. Hancock in his lectures at the Royal College of Surgeons. On the other hand, the most extreme state of constitutional exhaustion, previous to the operation of excision, may be followed by recovery after removal of the diseased bone; as the successful results in my own series of hip-joint cases, 1, 2, 4, and 6, clearly show.

(2.) Osseous anchylosis with malposition of the limb will *not* justify the peril of attempted excision. Subcutaneous section of the neck of the femur—the operation first proposed and practised by Mr. W. Adams—may be eligible; or my own operation (1872), of subcutaneous section below both trochanters. The limb can thus be brought down to a straight position.

(3.) The *extent of bone* diseased may be considerable, and involve both the femur and acetabulum. In the *femur* the diseased portion may include the head, neck, great trochanter, and shaft, entering even into the medullary canal. (Fig. 493.) In the *acetabulum* the diseased portion may include the whole floor of this cavity, and even extend to adjoining portions of the ilium, pubis, and ischium. Neither of these conditions of extensive osseous disease actually prohibits excision; but the acetabulum not unfrequently recovers itself when the diseased head of the femur has been removed from further contact and attrition.

Fig. 493.*



(4.) Dislocation is unfavourable for excision, as implying an advanced stage of the disease constitutionally. The significance of this local condition will, therefore, diminish in proportion to the absence of marked hectic and emaciation.

The *evidence* in support of these principles or rules for hip-joint excision is important, seeing that they are at variance, as I have said, with the results of former experience.

Firstly, respecting the *constitutional condition*. Advanced hectic, consequent on prolonged irritation and suppurative discharge in the last stage of the disease, will evidently have so reduced or exhausted the patient's reserve-power, as to peril the prospect of recovery, although the diseased bone be then removed by excision. The deliberate postponement of the operation until that period when constitutional exhaustion with emaciation is verging on dissolution, would be almost equivalent to operating on a corpse. By analogy, I would liken it to the postponement of operation for the relief of strangulated hernia until the patient is sinking in consequence; the Surgeon deliberately allowing the expenditure of the reserve-power requisite for recovery, without which operative interference must necessarily be a failure and the patient doomed. Hey's maxim respecting strangulated hernia is at least suggestive with regard to excision:—"I have often had occasion to regret operating too late, I have never regretted operating too early." It is no answer to this argument for timely operation as the rule, to point to exceptional cases of successful results at a later period, in the obviously adverse condition of constitutional exhaustion.

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* Royal Free Hospital. (Author.)

Osseous anchylosis of the hip-joint, with useless malposition of the limb, would seem to invite excision, to restore a straight limb and with a movable joint; but the difficulty of detaching the firmly soldered femoral head from the acetabulum, or the damage done by this procedure, would be such as to render the operation impracticable or fatal. Section of the femur *below* the trochanters, *between* the trochanters, or in the *neck*, has been proposed and practised instead; operative procedures of which I shall have to speak in due time.

Respecting the *extent of bone* which may be excised successfully, this element in the operation of hip-joint excision does not appear among the tabulated particulars of the majority of cases recorded. The portions of bone removed in each of my own cases are stated in the analysis of the series. As to the *femur*, in one case, I excised four and a half inches of the bone,—namely, head, neck, great trochanter, and two inches of the shaft, with about one inch more of the cancellated bone below, thence entering the medullary canal. That is, I believe, the largest femoral portion of bone which has hitherto been removed in any case of hip-joint excision on record. The patient recovered, with a thoroughly useful limb, and permanent result at the end of five years. Sir W. Fergusson removed four inches of the femur in one case.

The *acetabulum* is very rarely the seat of origin in hip-joint disease, yet that portion of the articulation rarely remains unaffected. Of ninety-two cases referred to by Mr. Hancock, in only eighteen the acetabulum was healthy. But the head of the femur is mostly diseased in a greater degree, it having been entirely absorbed in ten cases out of 143. In these 143 cases, also, the acetabulum was found more or less diseased in 119. In ten cases, an opening in the floor of the acetabulum communicated with the interior of the pelvis. In four cases, perforation had taken place, and abscess within the pelvis. In three cases, the acetabulum was trephined for the evacuation of pelvic abscess. Reparation may ensue in the diseased acetabulum, when the head of the femur is removed from contact and attrition; as attested by the results of cases of dislocation consequent on disease, which in so advanced a condition must have involved the acetabulum. Or, the disease may progress to perforation, followed by pelvic abscess, and a fatal termination. The fair inference is, that excision will be rendered more safe by removing any diseased portion, or even the whole floor, of the cavity. Thus, the acetabular, and even the *pelvic* portions of bone removed, with success, have varied considerably in size. In one case, Sir W. Fergusson removed nearly the whole of the acetabular cavity. In another case, Mr. Hancock removed the whole of the floor of the acetabulum, and the head of the femur. The patient recovered. In one case, Sayre, of New York, removed the acetabular cavity, with the spine and anterior crest of the ilium, as well as the head of the femur. The patient recovered. In another case, Mr. Bowman gouged the acetabulum, and the horizontal ramus of the pubes. The patient recovered. Lastly, Mr. Erichsen removed not only the whole floor of the acetabulum, but also the rami of the pubis and ischium, with part of the tuberosity of the ischium, and a portion of the dorsum ilii. The patient recovered. In my own cases, I have never had occasion, but once, to remove more than small portions of the acetabulum, which were scooped out in each case; the adjoining portion of the horizontal ramus of the pubes was denuded in one case, but it was left untouched and underwent repair. An exceptional case is now (1878) under treatment, where, in addition to an ordinary excision, about half the thickness of the ramus of the ischium was gouged out. As a rule, I find that superficial caries of any adjoining portion of pelvic bone is best left alone; rather than by groping about in the dark with a gouge, the vascular continuity of the integuments should be detached, and perhaps a portion of the carious surface may still be left unscraped. Nature, subsequently, completes the excision by molecular disintegration and discharge from the pelvic surface; with some prolongation only of the period of recovery, but with greater safety to the patient.

Lastly, *dislocation* is unfavourable, as implying an almost necessarily advanced stage of the disease constitutionally. Of 123 cases, more or less advanced to exhaustion, in forty-four only the head of the femur yet remained in the acetabulum.

Operation.—Excision of the hip-joint was originally proposed by White, of Manchester, in 1769, but the operation was first performed by Schmalz, of Pirnie, Saxony, in 1816; and first performed in this country, and for the second time in Europe, by Anthony White, of the Westminster Hospital, in 1821; it was repeated by Hewson, of Dublin, 1823; after which period the operation fell into disuse, until its revival by Sir William Fergusson, in 1845. Since that period it has been performed by many Surgeons, and in a large number of cases.

The hip-joint deeply placed, owing to the neck of the femur, is reached most conveniently by a T-shaped incision; the vertical line being made from just above the great trochanter downwards on the shaft to about three inches or less in extent, and the transverse line, perhaps slightly curved, about half that extent on the summit of the longitudinal incision. The very limited extent of this latter incision avoids the femoral vessels anteriorly, and the crural nerve posteriorly. In disease of the joint, with consequent dislocation backwards on the dorsum ilii, and wasting as the result of long-standing disease, these incisions seem to be almost invited, so prominently does the trochanteric portion of the femur abut under the integument. By detaching the integument on either side of the vertical incision, keeping the knife turned towards the femur, especially on its inner side, the subjacent portion of femoral shaft is exposed; then, sinking the knife vertically in the transverse incision, just above the trochanter, the attachment of muscles thereto is divided; so that the finger can be readily passed down to the joint and its state ascertained. The capsular ligament will generally have given way or entirely disappeared. To turn out the remnant head of the femur for excision, it may be necessary to adduct and evert the limb, when, with a touch of the knife on the bone, the round ligament yields and the head starts from its pocket. Or this ligament also may have disappeared, and the head and neck of the femur be so reduced, and the acetabulum so patulous, from more advanced disease, that the bone can be readily dislodged and hooked out with the finger. In a third class of cases, dislocation backwards has taken place. In any case, however, adduction of the limb across the opposite thigh presents the bone for application of the saw; and then the diseased portion is removed by one or more successive slices with a small saw, the integument on either side being protected by a curved retractor. (Fig. 494.) The chain-saw may be used by those who prefer it. (Fig. 495.) A gouge may be used to finish off the femoral excision; instead of unnecessarily removing any healthy portion of the trochanter, if that be left, or of the adjoining shaft. Instead of dislodging the portion of bone to be removed, I now more often excise *in situ*, by passing a long, narrow-bladed saw down to the line of section; the advantage being the much smaller wound requisite, and with less disturbance of the soft parts. The acetabulum should be scraped rather than gouged, to remove any carious or denuded portion; or more extensive pelvic excision may be necessary, and has proved successful. But superficial caries, acetabular or pelvic, will often recover itself, the former having been maintained by constant attrition of the femoral head. Any hæmorrhage is easily arrested by torsion. I have never had occasion to apply a single ligature in any hip-joint excision.

Fig. 494.

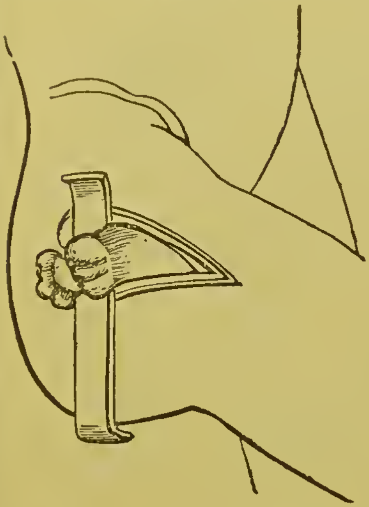
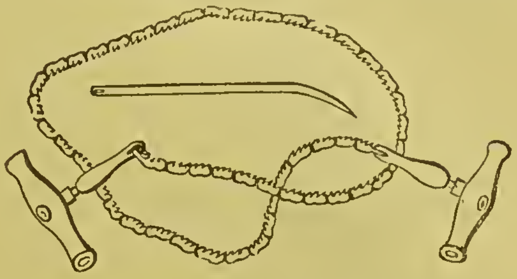


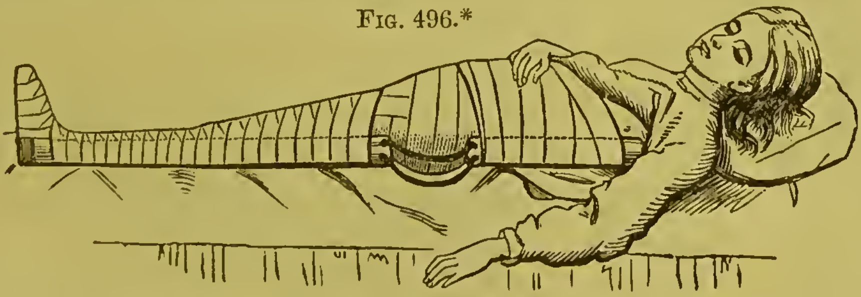
Fig. 495.



Excision of the trochanter major may ocasionally prove sufficient; caries of this portion of the femur existing, without disease of the hip-joint. I have had one such case, and with a successful result.

The *after-treatment* of excision, whether of the hip-joint or of the great trochanter alone, is very simple. The limb may be laid straight in bed, and retained in position only by small side pillows or roller sand-bags, without absolutely fixing the thigh; but weight-extension being used just to separate the section end of the femur from contact with the acetabulum. Or a long interrupted splint may be applied simply to fix the limb, without extension (Fig. 496); or, if extension be applied, it is best effected by a weight from the foot, rather than by means of a band attached to a broad thigh-belt on the *opposite* limb,—the band crossing the pelvis to be tied through the two holes at the

Fig. 496.*



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* Royal Free Hospital. (Author.)

top of the splint, according to the method recommended by Sir W. Fergusson. Of these two modes of after-treatment I prefer the former, especially for the joint-operation. The section end of the femur is drawn up by muscular action, and hitches just above the acetabulum, which having been, generally, more or less superficially carious, is thus left to recover itself, undisturbed by any attrition of the femoral end of bone; while a new, and firmly fibrous, movable joint forms, where the end of bone rests above the acetabulum. (Fig. 497.) In the case from which this specimen was taken, I had operated ten months previously, and although the patient died from pelvic abscess, with caries on the inner surface of the iliac bone, a perfect ball-and-socket joint had formed, with capsule, above the acetabulum, which was becoming obliterated. The anterior portion of the capsule is removed to show the new articulation of the bones. There is little or no tendency to displacement after hip-joint excision, and the slight extra shortening which results from thus leaving the limb to itself (Fig. 498) is unimportant compared with the advantages in regard to the acetabulum, and the formation of the best kind of new-joint requisite for the functional use of the limb, in progression, as well as for support. The annexed figure, drawn from one of my cases, represents this result; and which has now been of several years' duration, the little girl having grown to a young woman. (Fig. 499.)

Fig. 497.*

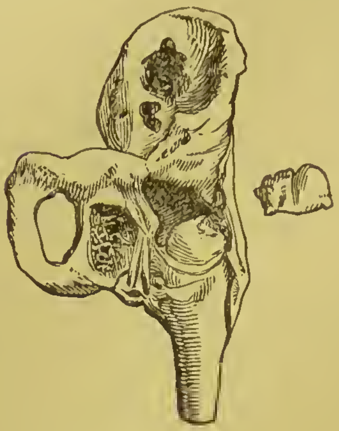


Fig. 498.*

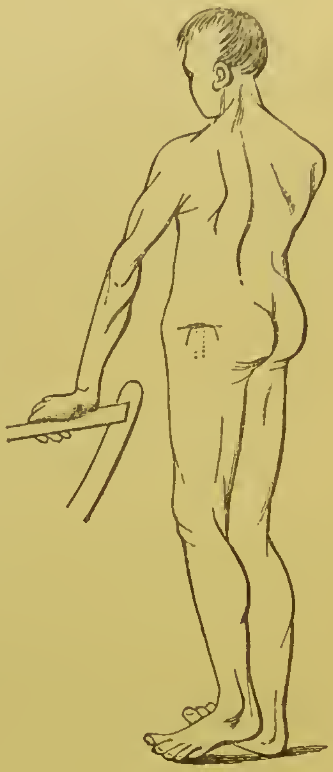
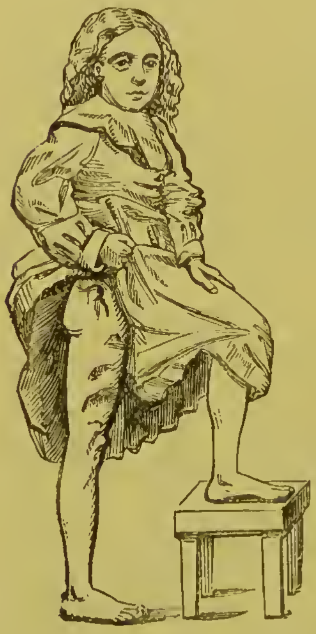


Fig. 499.*



Sub-periosteal Excision of Hip-joint.—The operation of excising a joint sub-periosteally, with the object of preserving the periosteum for the reproduction of bone, to obtain an increased length of limb, has been practised in the hip-joint more particularly. As I have already stated, in considering the general question of sub-periosteal excision, the results of this method have not seemed to warrant its alleged advantage with regard to the operation on *joints;* whatever may be the occasionally successful results of the same method after thus removing portions of the *shafts* of various bones.

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* Royal Free Hospital. (Author.)

In excision of the *hip-joint*, Professor Sayre lays much stress on preserving the periosteum; and, as he has practised this mode of performing that operation more frequently, I believe, than any other Surgeon, I shall here follow the description he has given of the requisite details, in his recent "Lectures on Orthopedic Surgery," etc., p. 288.

Having placed the patient on the sound side, under an anæsthetic, "select a strong knife, and drive it home to the bone at a point midway between the anterior inferior spinous process of the ilium and the top of the great trochanter; then drawing it in a curved line over the ilium, keeping it firmly in contact with the bone, make an incision across to the top of the great trochanter, extending it not directly over the centre of that process, but midway between the centre and its posterior border, and complete it by carrying the knife forward and inward, making the whole length of the incision from four to six or eight inches, according to the size of the thigh. Thus, a curved incision is made through all the soft parts down to the bone and *through the periosteum.* Then, an assistant, by means of retractors, draws the soft parts aside, and you come at once upon the great trochanter. With a narrow, thick knife, make a second incision through the *periosteum only*, at right angles with the first, at a point an inch or an inch and a half below the top of the great trochanter, just opposite the lesser trochanter, or a little above it, and extend it as far as possible around the bone. Here, again, make sure that the periosteum is *freely* divided. Very often a thick involucrum will be present, and great care will be necessary to make the incision through the periosteum complete. Now, we have first a curved incision through the soft parts; and second, a T-shaped incision through the periosteum, at the point indicated on the outside of the femur, just above the lesser trochanter. At the junction of the two incisions through the periosteum, introduce the blade of the periosteal elevator, and gradually peel up the periosteum from either side, together with its membranous attachments, until the digital fossa is reached. At this point the rotators of the thigh are inserted, and the attachments are so firm that you will not be able to peel them off, but will be obliged to divide them with the knife. In doing this, the knife should be kept close to the bone, to avoid a branch of the internal circumflex artery. Having divided the tendons, continue to elevate the periosteum upon either side as far as can be safely done without breaking it; thus to leave an entire periosteal sheath after the bone has been removed, in order to prevent any infiltration into the surrounding tissues, and to retain the muscular attachments for the future mobility of the joint. Slightly adduct the limb, so as to lift the head of the femur out of the acetabulum; in this way, the portion of periosteum that cannot be reached with the elevator is removed from the bone. But observe to turn the bone out only just enough to get the finger behind it for guiding the saw in its removal;

if too free a luxation be made, you will displace the periosteum too extensively, and the portion of bone thus uncovered will subsequently exfoliate. In excising the bone, always use a saw, a chain or a finger saw being most convenient, and make the section just above the trochanter minor; never through the neck, leaving the trochanter major, which would prevent a free discharge of purulent matter from the wound. The muscular attachments of the trochanter are preserved in elevating the periosteum. In some cases, as when the involucrum is so firm that the head of the bone cannot be lifted from its bed, luxation cannot easily be effected; then saw the bone *in situ*, and extract the portion with forceps or the elevator. If, after making the section, the living bone has not been reached, the periosteum must be further detached, by luxating the femur a little more, and slipping the bone through it, until living bone is reached—whether this requires one, two, three, or five inches of bone to be removed. If the periosteal involucrum possesses sufficient vitality, it may remain; but if it appears like carious bone, it must be removed. Next, examine the acetabulum; and, if diseased, all the dead bone must be carefully removed. If the acetabular cavity be perforated, the greatest care should be taken lest the internal layer of periosteum be injured. The internal periosteum will be found peeled off, or lifted away, forming a kind of cavity behind the acetabulum; and an exceedingly important point is to chip off all the edges around the perforation down to the point where the internal periosteum is reflected from the sound bone (!). This is one of the most delicate steps in the operation; to be able to remove all dead bone from the wall formed by the internal periosteum without injuring or wounding it (!). In some cases, when the operation is completed, there will be nothing intervening between the finger of the operator and the rectum of the patient, except this internal layer of periosteum. Lastly, thoroughly clean the original sinuses, carefully removing any bits of carious bone which may have lodged in their course during the progress of the disease, as well as the false membrane which lines them. Then, wash out the wound, fill it full of Peruvian balsam, and stuff it with oakum; never with cotton or lint, for they will not permit a free discharge from the bottom."

In following Professor Sayre's description of this sub-periosteal excision, it will be noted that he never contemplates anything approaching to primary union of the wound—such as often takes place to some extent after ordinary excision—without any attempt to save the periosteum. The periods of recovery, and the peril to the life of the patient, will be proportionately different after either mode of operation. And I have taken the liberty of interposing a sign of exclamation (!) here and there, where the points urged are simply impracticable, however much they may seem to be accomplished by the directions given.

Results.—(1.) In relation to life or mortality. In 111 cases, collected by Dr. Hodges, of *unrecorded conditions* of operation, 56 recovered, 53 died from the combined effects of the operation and the previous disease; and in the remaining 2 cases, amputation was resorted to. Thus about 1 in 2 died—a very high mortality. But Mr. Hancock presents the following very interesting results as to the mortality with reference to certain *guiding conditions* of disease for operation:—The *acetabulum*, in a healthy state, gave a mortality of 6 in 18 cases, or 33 per cent. On the other hand, acetabular *disease* has had more favourable results of operation. Of the 10 cases in which perforation had taken place, 6, or 60 per cent., recovered; 2 only, or 20 per cent., died. Of the 4 in which not only perforation existed, but abscess also within the pelvis, 2 recovered, 2 died—50 per cent. either way. Of the 3 in which the acetabulum was trephined for the evacuation of matter from the pelvis, 2, or 66 per cent., recovered; 1, or 33 per cent., died. Therefore, in the whole 20 of these apparently most unfavourable cases for excision, the mortality was only 5—1 in 4, or 25 per cent. The relation of *pelvic* disease to mortality after operation has already been noticed. *Dislocation* of the head of the femur having taken place, the percentage of recoveries was actually 46, against 23 where it had remained in its socket; the total number of cases compared being 143. Of my own first 8 cases of hip-joint excision, in 4 there was dislocation, and they all recovered equally with the 4 in which dislocation had not occurred.

Another equally large series of cases—112, British and foreign—has been collected by Dr. R. R. Good, late Surgeon in the Confederate American Army. This series is the more complete, as it embraces the most *essential particulars* respecting excision of the hip-joint for disease, both in regard to its mortality and the state of the limb. We are thus enabled to take a commanding view of the whole subject; and in order to observe the results and their relationship more clearly, I have tabulated them.

Tabular view of 112 cases of Hip-joint Excision, British and Foreign; Period, 1860–68.

MORTALITY.

Collection of Cases by Dr. R. R. Good.

(1.) Number of cases, 112.
(2.) Recoveries, 52, or 46·43 per cent.
Deaths, 60, or 53·57 „
Causes.—Exhaustion, 22. Phthisis, and progress of the disease, 10. Pyæmia, 5. Caries of the pelvis and purulent discharge, 4. Diarrhœa, 3. Exhaustion, with rapid pulmonary congestion, 2. Tubercular meningitis, tetanus, diphtheria, amyloid degeneration of the organs, diffuse phlebitis of the limb, osteo-myelitis, hæmorrhage, acute necrosis of the femur, nervous collapse and pneumonia; each 1.
(3.) Disease, recorded in 29 cases.
Scrofula, 3; 2 deaths, or 66·67. Cold, 4; 1 death, or 25·00. Injury, 20; 4 deaths, or 20·00. (2 cases not included.)
(4.) Duration previous to operation, recorded in 58 cases.
Average duration, 2 years 3 months. In *acute* cases, or before 7 months; of 9 cases, 7 deaths, or 77·77. In *chronic* cases, or 2 years and more; of 30 cases, 10 deaths, or 33·33; a balance in favour of chronic disease, 44·45.
(5.) Age, in the 52 recoveries; average, 11 years; extremes, were 2 years and 58 years.
„ in the 60 deaths; average, 14 years; extremes, were 3 years and 40 years.
„ from 2 to 12 years, 59 cases; 24 deaths, or 40·67.
„ 12 to 20 years, 25 cases; 15 deaths, or 60·00.
„ 20 to 58 years, 17 cases; 13 deaths, or 76·47.
(6.) Sex. 79 males.
30 females.
(3 sex unrecorded.)
(7.) Bone excised, recorded in 105 cases.
a. Femur; section above great trochanter in 49 cases, 30 deaths, or 61·23.

Section below great trochanter in 56 cases, 27 deaths, or 48·21. A balance in favour of section below,—13·01.

b. Acetabulum—*Diseased* in 72 cases, or 64·28. Deaths, 39, or 54·16.

Abscess of pelvis, recorded in 6 cases; 2 deaths.

Perforation in 11 cases (of the 72); 6 deaths, or 54·55.

Perforated surgically in 5 cases (of the 72); 1 death, or 80·00.

Gouged in 33 cases; 15 deaths, or 45·45.

No interference in 6 cases; 5 deaths, or 83·33.

—*Healthy* in 14 cases. Deaths 7, or 50·00. As compared with the mortality of diseased condition, 54·16; a balance of only 4·16 in favour of a healthy condition.

Dislocation, recorded in 17 cases; 6 deaths, or 35·29.

As compared with *non*-dislocation in 93 cases; 52 deaths, or 55·92. A balance of 20·63 in favour of Dislocation.

Countries.	*Cases.*	*Deaths.*
Germany	34	22, or 64·7
England	32	11, or 34·37
America	29	13, or 44·83
France	14	12, or 85·71
Russia	3	2
	112	

Author's Collection.

(1.) Charing Cross Hospital; period, 1862–70. (Per Mr. Hancock.) Number of cases, 15: recoveries, 13; deaths, 2.

(2.) Royal Free Hospital; period, 1863–70. Number of cases, 11: recoveries, 10; deaths, 1.

(3.) King's College Hospital; period, five years, 1870. (Per house surgeon.) Number of cases, 10: recoveries, 9; deaths, 1, six months after operation from tubercular meningitis.

(4.) London Hospital; period, five years, 1870. (Per Mr. J. McCarthy.) Number of cases, 10: recoveries, 4; deaths, 5; 1 progressing favourably.

(5.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 8: recoveries, 1; deaths, 5; 2 under treatment.

(6.) Westminster Hospital; period, five years, 1870. (Per Mr. F. Mason.) Number of cases, 6: recoveries, 6.

(7.) Guy's Hospital; period, 1864–69. (Per Mr. T. Bryant, from Dr. Steel, superintendent.) Number of cases, 6: recoveries, 5; deaths, 1.

(8.) Liverpool Royal Infirmary; period, five years, 1870. (Per Mr. W. J. Cleaver.) Number of cases, 4: recoveries, 3; deaths, 1.

(9.) Great Northern Hospital; period, five years, 1870. (Per Mr. J. Willis.) Number of cases, 3: recoveries, 3.

(10.) Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per Mr. P. H. Watson.) Number of cases, 3: recoveries, 1; deaths, 2.

(11.) St. Mary's Hospital; period, five years, 1870. (Per Mr. Gascoyen.) Number of cases, 2: recoveries, 2.

(12.) Royal Albert Hospital, Devonport; period, five years, 1870. (Per Mr. W. P. Swain.) Number of cases, 2: deaths, 2.

(13.) Royal Sea-Bathing Infirmary, Margate; period, five years, 1870. (Per Mr. J. R. Clouting.) Number of cases, 1: deaths, 1.

(14.) Royal Infirmary, Edinburgh; period, 1865–69. (Per Mr. P. H. Watson.) Number of cases, 1: deaths, 1.

(15.) St. Bartholomew's Hospital; period, 1866–70. (Per Mr. Callender.) No cases.

Taking the results of the preceding collections of cases, three *general* conclusions may be established respecting the rate of mortality from hip-joint excision, for disease:—(1.) In different countries, a very different mortality, being highest in France and lowest in England. (2.) An average death-rate of 1 in 4 or 5 (about the same as that of knee-joint excision, for disease). (3.) Very different death-rates in the hands of individual Surgeons, British and foreign—varying from no mortality, to 1 in 2 or 3, 1 in 5, 2 in 3, 4 in 5, or even total mortality; thus differing far more extremely than the mortality of knee-joint excision for disease. It can scarcely be doubted that the conditions of disease, both local and constitutional, in the cases selected for excision, have mainly determined this different resulting mortality; although the mode of performing the operation, and the after-treatment, have also been influential.

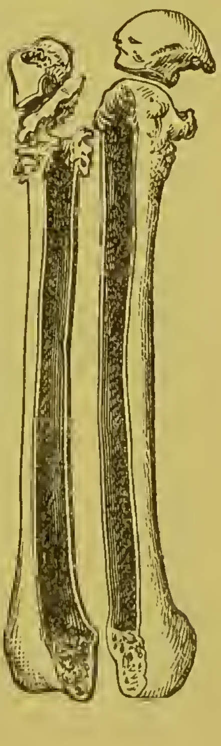
Mortality compared with Hip-joint Amputation.—In forty-two cases of amputation at the hip-joint for chronic disease, twenty-four recovered and eighteen died,—a mortality nearly as high as 1 in 2. It will be observed that the total number of cases here referred to is small in proportion to the number of hip-joint excisions for disease. But the whole number of hip-joint amputations hitherto published is only about 126, including the cases of injury and disease.

(2.) *State of the Limb.*—In Dr. Hodges' collection of 111 cases, fifty-six recovered "with more or less useful limbs." In Dr. Good's collection of 112 cases, of the fifty-two recoveries, forty-two patients could use the limb, and in the remaining ten cases this result was not noted. The forty-two cases are divided as follow:—

19 could walk without support.
9 ,, with the help of a stick.
1 ,, ,, two sticks.
1 ,, ,, a splint.
1 ,, ,, a crutch.
2 ,, ,, two crutches.
9 the manner of walking is not specified.

In forty of the fifty-two recoveries, it was specially noted that the limb supported the weight of the body. In one case crutches were necessary for this purpose, and in the remaining eleven cases this particular was not noted. The movements in the new joint were reproduced in twenty-eight cases, and in only one immovable anchylosis was the result. The ultimate period when the patients were seen after operation, varied from three months to five years. Their cure was ascertained, in most cases, after two or three years. Of the fifty-two cured, the average period of known permanent result was nineteen months and four days. In my own eight cases, the shortest period of known permanent cure was two and a half years, and the longest ascertained result five years.

Fig. 500.*



Atrophy of the *shaft* of the femur has been known to occur in consequence of excision of the head and great trochanter (Fig. 500); the cancellous tissue having disappeared, and the walls of the shaft being reduced to a shell of compact bone, fracture would be apt to take place in the act of standing or walking. But this contingency after excision is very rare, the bone generally retaining its former strength.

The *average duration of the period of recovery* has not generally been noted in the records of cases.

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* Roy. Coll. Surgeons Mus., 941A.

In Dr. Hodges' collection of forty-nine cases wherein this particular was observed, the average was 230 days. In my own cases, the average period of *union* was three months.

In extreme cases of hip-joint excision—extreme as to the extent of bone removed—the resulting state of the limb may yet be successful. It was so in my own two such cases, after removal of the upper end of the femur, to four inches and four and a half in length, with one inch more of cancellated bone, and entering the medullary canal, in both cases; and also in both the cases of acetabular and pelvic bone-disease, after removal of the affected portions of bone by Mr. Hancock and Mr. Erichsen respectively,—the patients recovering, and with useful limbs.

The following is a summary of some of my own hip-joint cases, as *typical* illustrations of the conditions of disease which are appropriate for excision, and the results, proximate and permanent, in each case; an analysis being appended, with reference to the several *questions* of importance pertaining to excision of the hip-joint for disease.

I have drawn up these cases from clinical notes carefully taken—in the first two by Mr. John B. Foster, in the second two by Mr. Marriott, formerly house surgeons; and in the remaining four, by Mr. T. C. Murphy, formerly senior house surgeon, at the Royal Free Hospital.

TYPICAL CASES OF HIP-JOINT EXCISION.—CASE 1.—William M——, æt. 26; admitted into the Royal Free Hospital March, 1864. *Scrofulous caries* of the left femur; the head and the articular cartilage entirely destroyed, the neck, great trochanter, and one inch of shaft involved, with one inch more of cancellated structure; similar disease of acetabulum, and horizontal ramus of pubes; *dislocation* on dorsum ilii with abscess; constitutional condition, *advanced hectic;* disease of traumatic origin; duration of disease, four years; treatment, three years. *Excision* of four inches of femur, and one inch of cancellated structure. *Recovery*, with a freely movable joint and a useful limb, in three months. *Permanent* result known after two years and a half.

CASE 2.—John R——, æt. 16; admitted into the Hospital July 22nd, 1863. *Caries* of left femur; its neck and great trochanter, the head involved, with circumferential destruction of the articular cartilage, and disease in the shaft to two inches in extent, with one inch more of cancellated structure; similar disease of acetabulum; *dislocation* on dorsum ilii with abscess; constitutional condition, *advanced hectic;* immediate cause, cold; duration of disease, one year. *Excision* of four inches and a half of femur, and the one inch of cancellated structure. *Recovery*, with a freely movable joint, and a useful limb, in two months and a half. *Result* known to be *permanent* after five years.

CASE 3.—George C——, æt. 15; admitted into the Hospital June 9th, 1864. *Caries* of right femur; its head and neck entirely destroyed, great trochanter and a small piece of the shaft involved; similar disease of acetabulum; *dislocation* and abscess on dorsum ilii; *health good;* disease of traumatic origin; duration of disease, two years. *Excision* of one inch and three-quarters of femur. *Recovery*, with a freely movable joint and a useful limb, in three months.

CASE 4.—Edward M——, æt. 8; admitted into the Hospital June 10th, 1864. *Caries* of left femur, its head and neck destroyed; similar disease of acetabulum; advanced hectic; immediate cause, cold; duration of disease, five years. *Excision* of two inches of femur. *Recovery*, with a movable joint and useful limb, in two months.

Case 5.—Jane L——, æt. 5; admitted into the Hospital March 4th, 1867. *Caries* of right femur, its head and neck destroyed; similar disease of acetabulum; health good; disease of traumatic origin; three years' duration, two and a half years' treatment. *Excision* below great trochanter. *Recovery*, with a movable joint and useful limb, in four months. *Result* known to be *permanent* after three years.

Case 6.—Catherine R——, æt. 5; admitted into the Hospital October 31st, 1866. *Scrofulous caries* of left femur, its head and neck destroyed; similar disease of acetabulum; *dislocation* and abscess on dorsum ilii; advanced hectic; disease apparently of traumatic origin; one year and eight months' duration, and treatment. *Excision* below great trochanter. *Recovery*, with a movable joint and useful limb, in three months.

For the particulars of this case I am indebted to my late colleague, Mr. John D. Hill, then senior house surgeon in the Hospital.

In *two* other cases, the essential particulars were similar to one or other of the above series.

Analysis of the Cases.—The following facts respecting the foregoing cases of hip-joint disease and excision seem specially worthy of notice.

(1.) *Conditions of Disease.*—Caries in all cases, with destruction of the femoral articular cartilage, entirely in 1, 3, 4, 5, 6, or in five cases; circumferentially only in Case 2. Extent of bone diseased was the head and neck in each case; with the great trochanter and portion of the shaft in Cases 1, 2, 3; and an extra portion of cancellated structure of the shaft in Cases 1 and 2; caries of the acetabulum to some extent in all cases, and of ramus of pubes in Case 1; dislocation on dorsum ilii in Cases 1, 2, 3, 6, or in four out of the six cases.

(2.) *Immediate Cause.*—Injury in Cases 1, 3, 5, 6; cold in 2, 4.

(3.) *Constitutional Condition.*—Advanced hectic in Cases 1, 2, 4, 6, or in four of the six cases; health good in Cases 3 and 5.

(4.) *Previous Duration of Disease.*—Four years, one year, two years, five years, three years, one year and eight months. *Previous Duration of Treatment.*—Case 1, three years; Case 5, two and a half years; Case 6, one year and eight months.

(5.) *Age and Sex.*—Age: 26, 16, 5, 8, 5, 5 years. Sex: four males and two females.

(6.) *Operation.—Incision* T-shaped in all cases. *Portions* of *bone* excised: (1) Four inches of femur, and one inch of cancellated structure scooped out; (2) Four inches and a half of femur, and one inch of cancellated structure scooped out. In both these cases the medullary canal was entered. (3) One inch and three-quarters of femur; (4) Two inches of femur; (5) Section just below great trochanter; (6) Section just below great trochanter. Small portions of the acetabulum were scooped out in each case. *Hæmorrhage* inconsiderable in all the cases. No ligatures required. Silk sutures and water-dressing applied in all the cases. *No splint* was used in any of the cases, the section of the femur being left free to form a fibrous anchylosis.

(7.) Primary union ensued in all the cases, except the first, wherein the wound healed by granulation.

(8.) *Results.*—Firm fibrous anchylosis, with a movable joint and useful limb in all the cases. Period of union, average three months.

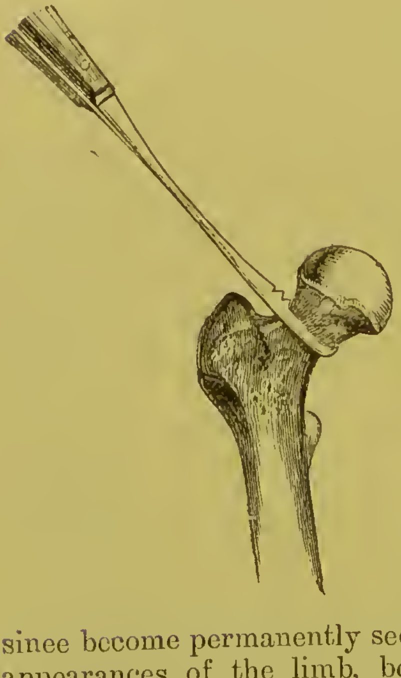
(9.) Result known to be *permanent*; in Case 1, after two and a half years; in Case 2, after five years; in Case 5, after three years.

Section, instead of Excision, of the upper end of the femur, is a procedure which has been devised and practised for failure of the natural cure,—osseous, instead of ligamentous anchylosis of the joint, with useless malposition of the limb, as by flexure on the thigh and adduction.

The femur has been divided, either between the trochanters, or in the neck, or just below both trochanters; and with successful results. In the first-named situation, section was originally proposed and performed by Dr. Rhea Barton, of Philadelphia, in 1826. A crucial incision was made over the great trochanter, seven inches in length and five inches in the horizontal direction; a fine saw was introduced, the femur divided transversely between the trochanters, and the limb brought down. The result was successful; an artificial movable joint formed; but seven years afterwards, anchylosis ensued, and two years subsequently the man died of phthisis, nine years after the operation. A similar operation in situation—between the trochanters, but an *excision* of a transverse plate of bone, of an elliptical form upwards, by means of the chain-saw, was performed by Dr. Lewis A. Sayre, of New York, in two cases, both in the year 1862. The object of this procedure was to form a false joint, of a ball-and-socket character. The first case was completely successful at the end of six months, the patient, aged twenty-six, being able to stand on either leg without crutch or cane; and upwards of five years afterwards the result was permanent, the man could move and walk with practical agility. In the second case, the operation was followed by abscess and necrosis; but the patient, a female aged twenty-four, died, apparently of tubercular pneumonia. Post-mortem examination showed that an artificial joint had formed; the articular surfaces were tipped with cartilage and provided with a synovial membrane, and there was a complete capsular ligament.

Subcutaneous section, and higher up, in the neck of the femur, was first proposed and practised by Mr. William Adams, in December, 1869. The object of this procedure was to procure an artificial movable joint; that result having failed, osseous anchylosis, but with the limb in a straight position, was sought to be established, and obtained. A long tenotomy knife was entered a little above the great trochanter, and passed down to the neck; the capsular fragment was opened freely, and the neck of bone divided by a narrow saw, applied from before backwards. (Fig. 501.) The tendons of the long head of the rectus, the adductor longus, and tensor vaginæ femoris muscles, were then divided; the limb was brought down straight, and fixed by a long interrupted Liston's splint. Five months after this operation, and subsequent treatment, the man, aged twenty-four, was exhibited at the Medical Society of London, where he walked about the room without any assistance—a successful result which has since become permanently secured. The annexed figures represent the appearances of the limb, before and after operation; in the latter, the patient standing on the limb, to show the restored usefulness of the member. (Figs. 502, 503.)

FIG. 501.



This operative procedure has since been practised in twenty-one cases, collected by Mr. Adams;* Mr. T. R. Jessop, of Leeds, having had the second case; followed by Mr. Furneaux Jordan, of Birmingham; Mr. F. W. Jowers, of Brighton; Dr. Sands, of New York; Mr. Lund, of Manchester; Mr. T. Bryant, and other Surgeons. In this series of cases, eighteen were successful, which, with Mr. Adams's first case, makes a total of nineteen, out of the whole number, twenty-two; leaving a proportion of three deaths. Of the successful cases, in two, both hips were submitted to operation. It is important also to note that only one case was fatal from pyæmia; in the other two, subcutaneous section was followed by suppuration and necrosis, for which exarticulation of the hip proved fatal, or death ensued from prolonged suppuration and kidney disease at the end of eight months.

FIG. 502.

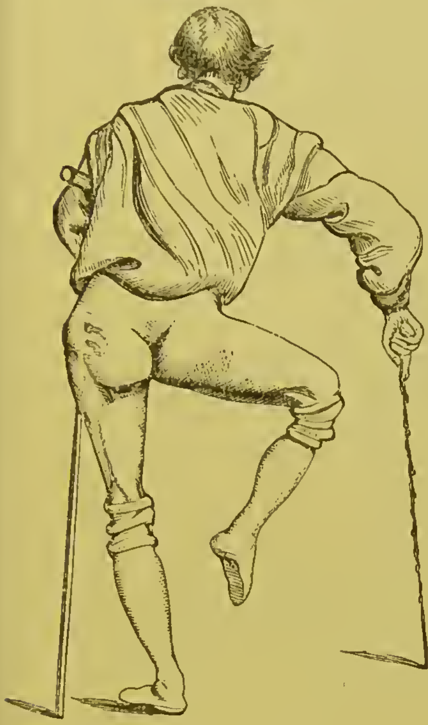


FIG. 503.

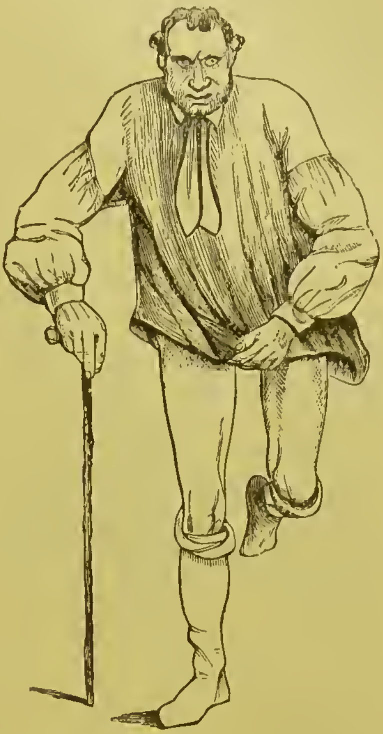
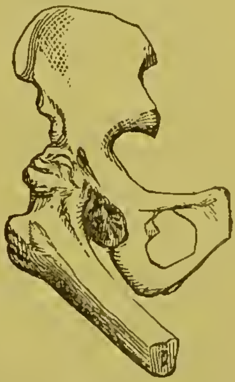


FIG. 504.†



The merits of Mr. Adams's operation are now sufficiently verified by accumulated experience in the hands of different Surgeons, as to leave no doubt of its future success, when properly performed—by the *subcutaneous* method—and in properly *selected* cases of hip-joint disease, resulting in osseous anchylosis, with useless malposition of the limb. (Fig. 504.) But there are *two* classes of cases to which subcutaneous section of the *neck* of the femur is inapplicable; the resulting anchylosis and malposition of the limb being the same.

Firstly, scrofulous disease of the hip-joint, in an *advanced* stage;

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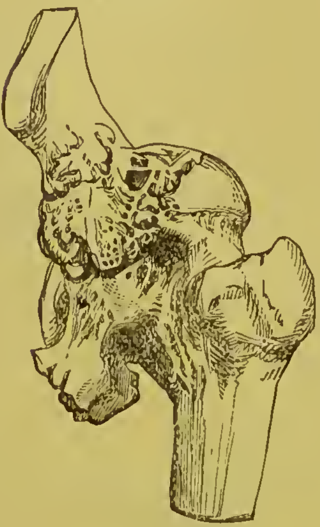
* "Med. Chir. Trans.," lx., 1877.

† Royal Free Hospital Mus.

with destruction of the head, and of the neck of the femur so far as to leave only a nodule of bone above the great trochanter. An approach to this condition is represented in the figure. In such case, Adams's operation must be ineligible, there being no femoral neck to divide. The amount of shortening, as determined by accurate measurement of the limb, coupled with the duration of the disease, will afford the only indications as to the probable extent of destruction in the neck of the femur. Assuming that, under these circumstances, the requisite conditions of anchylosis and malposition have taken place, some other operative procedure, than in the small remnant nodule of the neck, must be resorted to. It was in such a case as this condition of the joint, that it seemed to me absolutely necessary to remove the seat of subcutaneous section to another part of the femur; and two considerations induced me to select a line of section *just below the trochanters*, rather than through the great trochanter—as in the operations of Rhea Barton and Sayre, and neither of which procedures were performed by the subcutaneous method. The new *site* of the operation I proposed, was indicated by the pathological fact that the section would not be made in any presumably diseased portion of the femur, but in sound bone; and another consideration was the anatomical or physiological fact that, the section being below the small trochanter, the resisting psoas and iliacus muscles would be set free, in order the more effectually to overcome malposition of the limb. To these reasons in favour of this infra-trochanteric operation, may be added the absence of any risk of atrophy or necrosis of the remnant head or neck of bone, by cutting off its vascular supply; and that, in *young* subjects, separation of the epiphysial head of the femur might be followed by shortening of the limb; both these contingencies having special relation to Adams's operation in the neck of the femur.

Fig. 505.*



Secondly, another class of cases inappropriate for the latter operation is when the resultant anchylosis is attended with an exuberant deposit of new, nodular, and hard bone around the neck of the femur, producing considerable thickening and induration of the bone in that situation; as in chronic rheumatic arthritis. (Fig. 505.) Accordingly, in such case also, I would transfer the site of section to below the trochanters.

Subcutaneous Section of the Femur, *below* the *Trochanters.*—The *Infra-Trochanteric* Operation.—I first performed this operation on December 10th, 1872, as reported in the *Lancet*, December 21st. The patient lying down, the thigh about to be operated on is directed across that of the opposite side, owing to the angle of malposition. I grasp the front of the thigh with the left hand, below the trochanters, and turn the mass of muscle somewhat outwards, planting my thumb rather below the outer side of the femur, to mark the point of incision. A stout tenotomy knife, set in a long handle, is entered at that point, and passed down to and over the femur, so as to make a transverse line across the bone; then the knife is withdrawn, and still keeping the thumb in position, not to lose the track of the narrow subcutaneous incision, a thin, narrow-bladed saw, set in a long handle, is entered at the same point, and passed along the track of the wound, over the femur (Fig. 506), which is then readily sawn through, observing not to work the instrument beyond the length of the serrated portion, about two inches in extent, thus to avoid lacerating the soft textures on either side of the shaft. Only a few drops of blood escape from the puncture-wound, without any perceptible *débris* of bone. On feeling that the thigh is suddenly loose and movable at the seat of section, the thumb of the left hand is slid over the puncture, followed by a similar application of a lint compress as the thumb is withdrawn, in order to preclude the admission of air; thus making this subcutaneous osteotomy exactly similar to a subcutaneous tenotomy. The compress is secured by cross strips of adhesive plaster, and further by the turns of a rolled bandage, pretty firmly applied around the thigh. This having been done, the limb is brought down in a straight position from below the seat of section, making a more or less perceptible angle with the trochanteric portion above. In bringing the limb down, some resistance may be felt, owing to long-continued contraction of the muscles in the direction which the thigh has assumed. This will be overcome by proper manipulation. The limb having thus been straightened as nearly as possible, a long, straight, interrupted splint is applied, as for excision of the hip-joint, and bandaged in the usual manner. In the event of muscular contraction, it may be desirable to use weight-extension from the ankle, as in fracture of the thigh.

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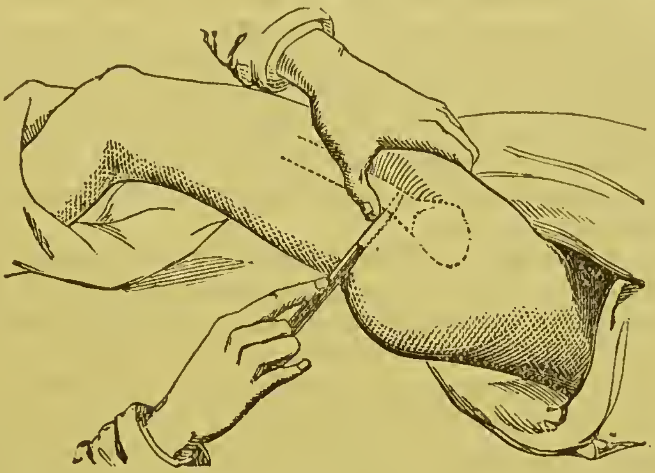
* St. Bartholomew's Hosp. Mus., B. 4.

Fig. 506.



This simple operation of infra-trochanteric, subcutaneous section can be easily performed in the course of two minutes. The thin, narrow blade of my saw is well fitted for this purpose; and the serrated edge is made thicker than the back of the blade, so as to clear the way for the easy passage of the instrument,—this adaptation preventing any locking of the blade in the shaft of the femur, which would be otherwise apt to occur, especially when the whole thickness of the shaft is nearly divided. The compress should not be removed from the puncture for a week or ten days; unless pain and swelling should indicate the probable supervention of some suppuration. On removing the compress, the puncture may be quite closed, and *dry*, with a little circle of redness around. And this primary union may be permanent, as in my first case of infra-trochanteric section, in a boy six years old. In the second case, a scrofulous boy, aged fourteen, some oozing ensued. Therefore, in any case, however favourable its progress, the compress should be reapplied, and continued, as a safeguard, during the course of reparation.

Osseous union takes place in six weeks or two months, according to the age of the patient; and the formation of an intermediate callus is unaccompanied by any notable inflammatory symptoms. In the event of discharge from the puncture-wound, the compress must be removed, in order to give free vent to the serous or purulent fluid; and the case is then to be treated as one of compound fracture, without however being complicated by comminution of the bone, or laceration of the surrounding muscles.

Dr. John Ashhurst, of Philadelphia, has performed subcutaneous section of the femur on *both* hips, in the same patient; on the left side, "Adams's operation"—through the neck, and on the right side, "Gant's operation"—just below the trochanters. In this case a child, nine years old, had anchylosis of both hip-joints, consequent on "strumous disease;" in the right hip, the neck of the femur seemed to have entirely disappeared, and hence the preference, or rather the possibility only, of my operation. The result, at the date of communication to Mr. Adams, was satisfactory; the limbs being parallel, and of nearly the same length. (See *Lancet*, Nov. 25th, 1876.)

In the most recent case, with the particulars of which I am acquainted, I witnessed the operation as performed at St. Thomas's Hospital by Mr. Croft; the puncture-wound having been made, and the bone sawn partly through, under the influence of the antiseptic spray, at the "posterior fifth of the shaft, the bone was broken by a movement of extension and rotation inwards. The limb was easily placed in a satisfactory position. A little blood oozed from the wound for a few seconds after the operation, the sawing having occupied four minutes. As soon as the oozing appeared to have ceased, the wound was covered by a compress of lint saturated with oil and carbolic acid (one to twenty), and a layer of antiseptic gauze was bandaged on. A bracketed long outside splint was then applied." Thus, in this case, the operation was departed from in certain particulars, which I deem essential to success. The bone was partly *fractured*, and perhaps, therefore, splintered; and air was allowed to enter through the puncture-wound, after dividing the bone. The procedure was *not* subcutaneous, from first to last, under command of the thumb and compress. The operation was also performed *antiseptically*. Primary union did not take place; the wound discharged copiously, a blood-stained serum, odourless, but afterwards purulent and offensive. In a month the antiseptic dressings were discontinued, yet soon an abscess was found, burrowing towards the anterior superior spine of the ilium; this was opened, and the patient became very weak from constant suppurative discharge. At length, however, after six months, he was able to walk with a stick, and soon "he could move about with ease, go up and down stairs quickly, and walk a considerable distance without fatigue. He said that he would willingly go through a similar illness again for an equally good result." (See "Trans. Clin. Soc., Lond.," vol. x., January 26th, 1877.)

I am indebted to Mr. W. Adams for the particulars of the following case, in which he performed this operation, and with an entirely successful result:—

"On the 24th October, 1877, Mr. Wm. Adams, at the Great Northern Hospital, performed Mr. Gant's operation of subcutaneously dividing the shaft of the femur with a small saw, just below the small trochanter.

"The case was that of a woman, æt. 32 years, who had been unable to stand for three years, in consequence of severe contraction of both hip-joints, as well as knee and ankle joints. The contraction took place a month after a miscarriage, followed by very severe hæmorrhage, and extreme prostration. No history of pyæmia or rheumatism. Three months after the miscarriage, she was admitted into one of the Metropolitan Hospitals, in consequence of the contraction of the legs; and dislocation of the right hip-joint, with the head of the femur on the dorsum ilii, was observed. This was supposed to have occurred spontaneously during the extreme exhaustion, when the contraction occurred.

"Forcible extension was twice employed, and she remained eight months in the hospital. The skin gave way in several places at the time of extension, in a very remarkable manner, and the wounds interfered with the subsequent treatment.

"Mr. Adams preferred Mr. Gant's operation in consequence of the thickening and displacement of parts, which obscured the relations of the head and neck of the femur. The division of the bone was accomplished in one minute, and the limb was at once brought into a straight position, and a long interrupted straight splint applied.

"The wound united by the first intention, not a drop of pus being seen, and altogether the union of the bone proceeded as in a case of simple fracture.

"January 3rd, 1878.—The union is now firm and the limb straight."

Since the introduction of this operation, which, having regard to the conditions appropriate for the procedure, essentially consists in the situation of subcutaneous section—just below the trochanters—Mr. Maunder has practised the same "subcutaneous ostestomy" by means of Volckmann's chisel, instead of the small saw I originally used; the operation as thus performed by Mr. Maunder differing only in the kind of instrument which he prefers. His first operation was in 1875, July 7th.

Mr. Maunder has supplied me with the following particulars relative to all the cases wherein he has performed subcutaneous osteotomy of the femur; although it does not appear that in all the section was made just below the trochanter, as the alternative procedure to division of the neck of the femur by Adams's operation. He writes, "I have divided the femur twelve times. In the four first cases with *three* chisels, as recommended by Volckmann; and of these two suppurated slightly, but from remedial causes, one of the chisels being improperly tempered. For section of the remaining eight (excluding other bones) I have used *one* chisel, selected by myself from the workshop of an amateur carpenter, of peculiar shape and temper. Thus, out of twelve sections of the femur, two suppurated superficially; while in ten *primary* union occurred. Many Surgeons have used my pattern of chisel without a drop of suppuration; and even in Mr. Bryant's wretched patient, the wounds healed primarily." (See *Lancet* of December 22nd, 1877.)

In the case referred to, the patient was a "cachectic-looking boy, aged seventeen;" and disease of both hip-joints having advanced to destruction of the neck of either femur, Mr. Bryant resorted to my operation below the trochanters,—using, however, Volckmann's chisel. The incisions healed by primary union; but deep-seated suppuration ensued over the sacrum, followed by pyæmic infection, of which the boy died.

ANKLE-JOINT.—The operation of excision with regard to the ankle-joint has been confusedly described in Surgical works as signifying the removal of any portion of the foot, whether pertaining to the ankle-joint or not; in the operations originated by Liston, Wakley, and Teale. But, by excision of the ankle-joint, I mean the removal of the articular surfaces of the bones which enter into the formation of this joint—namely, the lower articular ends of the tibia and fibula, and the upper portion of the astragalus.

This operation, first performed for *injury* by Hippocrates, and revived by Hey, of Leeds, in 1766, was first performed for *disease* by Moreau, senior, in 1792; then by Moreau, junior, in 1796; next by Mulder, in 1810; and probably by Champion, in 1813. But the credit of introducing the operation into British Surgery is due to Mr. Hancock, who excised the ankle-joint for disease in February, 1851. The operation has since been resorted to by Professor Humphry, of Cambridge, in four cases, and by other Surgeons, including myself.

The Conditions of Ankle-joint Disease appropriate for Excision.—Disease of the ankle-joint, according to Mr. Hancock, frequently commences in the synovial membrane, and extends to the articular surfaces; thus, secondarily, involving the bones. But it may also commence, as scrofulous disease, in the cancellous tissue of the long bones—tibia and fibula, or of the astragalus, or of all three bones. In the former condition, the affected portion of the articular surfaces may be removed with safety and advantage. In the latter condition, excision is not inappropriate.

Other and different opinions are held by some Surgeons of repute, as by Mr. Furneaux Jordan, of Birmingham, both with regard to the origin of disease of the ankle-joint, and the propriety of excision. That disease rarely extends from the synovial membrane, but begins in the cancellous tissue, either of the extremities of the tibia and fibula, or in that of the astragalus; and, it is said, necessarily affects the whole of that bone. In the one condition, excision of the extremities of the long bones, as the local source of the disease, is said to be inadmissible; while, in the other condition, the whole bone—astragalus—must be excised. The former contra-injunction is plainly at variance with the established practice of excision in disease of the knee-joint, under strictly analogous circumstances—when the end of the femur, or head of the tibia, is the seat of disease. Excision of the extremity of either of these long bones is not inadmissible, but only, perhaps, less favourable in scrofulous disease of the cancellous tissue.

The fair inferences from this diversity of opinion respecting the diseased conditions of the ankle-joint for which excision is appropriate, would appear to be:—

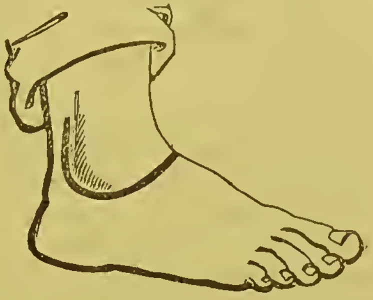
(1.) When disease, commencing in the synovial membrane, has extended to and destroyed the articular surfaces of the tibia and fibula, that of the astragalus, or of both opposed surfaces.

(2.) When disease, having the same articular consequences, commenced in the cancellated tissue, either of the long bones or of the astragalus, provided it be limited to part of this bone,—its upper articular portion.

(3.) Whether the disease originated in the synovial membrane or in the articular cancellated tissue, resulting in destruction of the cartilages, without anchylosis, excision should be resorted to *before* the supervention of constitutional exhaustion.

Operation.—Hancock's description of excision of the Ankle-joint, as first performed by him in England (1851), is as follows:—"I commenced an incision behind, and about two inches above, the external malleolus, carrying it forwards beneath that process across the front of the joint, and terminating about two inches above and behind the inner malleolus. (Fig. 507.) This incision included the skin, without implicating the tendons or their sheaths. The flap thus formed was dissected up, and the peronei tendons were detached from the groove behind the fibula and cut through, as were the external lateral ligaments close to the fibula, with a pair of bone-nippers. I next divided the fibula about an inch and a half above its inferior extremity, and cutting through the inferior tibio-fibular ligaments, detached the external malleolus. Turning the leg on to its outer side, I cut through the internal lateral ligament, carefully keeping the knife close to the end of the tibia, to avoid the posterior tibial artery. The tendons of the tibialis posticus and flexor communis were then detached from the groove behind the internal malleolus, and taking the foot in both hands, Mr. Avery holding the leg, I dislocated the foot outwards, thus bringing the end of the tibia, with the internal malleolus, prominently through the wound. These were removed by a common amputating saw, applied half an inch above the horizontal articulating surface of the tibia, the soft parts being protected by a spatula; the upper articulating surface of the astragalus was also removed by a metacarpal saw, held horizontally. The foot was then restored to its proper position, the cut surface of the astragalus being adapted to the cut surface of the tibia; and the wound having been closed by sutures, except on the outer side, left open for the free escape of discharge, the leg was placed on an external splint, having an opening corresponding to the wound."

FIG. 507.*



The parts divided by this operation were—the skin, peronei tendons, internal and external, lateral and inferior tibio-fibular ligaments, and the articular surfaces of the bones. In subsequent operations, the tendons were preserved entire. In no instance have the tibial arteries, anterior or posterior, been wounded, and never has it been necessary to apply a single ligature.

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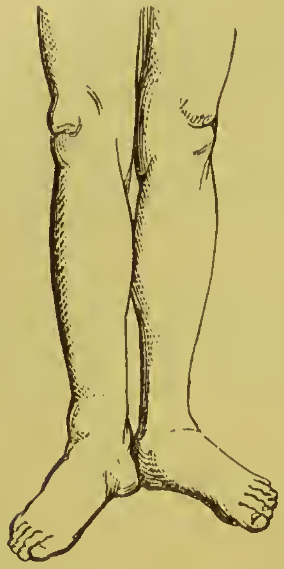
* After Hancock.

Lateral incisions alone, without the anterior communication, have since sufficed. This was my mode of operation in two cases.

The After-treatment of ankle-joint excision should be conducted in accordance with the principles laid down respecting the excision of other joints; regard being had to the kind of anchylosis necessary for the use of the limb. The fixed position of the foot must be maintained during the period requisite to secure a firm fibrous union of the osseous surfaces made by excision—the lower ends of the tibia and fibula, and the upper surface of the astragalus; thus to adapt the foot for support and progression. (Fig. 508.) The wounds, one on either side of the ankle, are dressed from day to day; but the splint should be removed and reapplied *very seldom*. In my own excisions of the ankle-joint, I have fixed the leg on a flat back-splint, provided with a foot-piece; thus secured, displacement can scarcely occur, and the side wounds are freely accessible for cleansing and dressing. Eventually, a starched bandage may be applied; and the foot being slung from the neck, the patient gets about on crutches, as the foot is gradually brought into use.

FIG. 508.*



Results.—Excision of the Ankle-joint, for disease, presents some most interesting results, both in relation to the mortality of this operation, and the state of the foot, with the probability of secondary amputation; both these aspects of the operation being considered also as compared with amputation of the leg, and with Syme's and Pirogoff's operations of amputation at the Ankle-joint, for disease.

For certain valuable statistics bearing on these important questions, I am indebted to Mr. Hancock, who liberally placed at my disposal the manuscript of his Lectures at the Royal College of Surgeons.

(1.) In relation to Mortality.—The results of 32 cases of excision of the ankle-joint for *disease* have been collected by Mr. Hancock; all that he could find recorded in the practice of British Surgeons. Of these 32 cases, 7 died—about 1 in 5, or a fraction above 21 per cent. But of the 7 deaths, 4 are reported to have died of consumption, 1 suffering from that disease at the time of operation; while another died of secondary syphilis. This reduces the average mortality to 1 in 16, or about 6 per cent. Of my own two cases, both lived.

Author's Collection.

(1.) Charing Cross Hospital; period, 1858–65. (Per Mr. Hancock.) Number of cases, 6: recoveries, 6; amputation after excision, 1; recoveries, 1.

(2.) Royal Free Hospital; period, five years, 1870. Number of cases, 4: recoveries, 4; amputations after excision—Syme's amputation, 1; recoveries, 1.

(3.) Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per Mr. P. H. Watson.) Number of cases, 4: recoveries, 4.

(4.) Royal Infirmary, Edinburgh; period, 1865–69. (Per Mr. P. H. Watson.) Number of cases, 3: recoveries, 2; deaths, 1.

(5.) St. Bartholomew's Hospital; period, 1866–70. (Per Mr. Callender.) Number of cases, 1: recoveries, 1.

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* Roy. Med. Chir. Trans., vol. lvii. Mr. H. Lee's case of excision of ankle-joint, for injury.

(6.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 1: deaths, 1.

(7.) London Hospital; period, five years, 1870. (Per Mr. J. McCarthy.) Number of cases, 1: recoveries, 1; amputations after excision, 1; recoveries, 1.

Guy's, King's College, Westminster, St. Mary's, and Great Northern Hospitals; Liverpool Royal Infirmary; Royal Albert Hospital, Devonport; and Royal Sea-Bathing Infirmary, Margate; period, each five years, 1870. No cases.

Compared with the Mortality of Amputation.—(*a*) in the leg; (*b*) at the ankle-joint—Syme's and Pirogoff's amputations of the foot.

(*a.*) *Amputation of the leg*, for disease, in Civil Surgery, has a mortality of 26 per cent.; whereas, in the results of ankle-joint excision for disease, the mortality, as already quoted, has been only 6 per cent.; 20 per cent. difference in favour of excision.

(*b.*) *Amputation at Ankle-joint—Syme's Amputation.*—Of the *whole* number of Ankle-joint amputations—219, as collected by Mr. Hancock, in 144 amputation was performed for disease—caries. Of these, 10 only were fatal, or somewhat less than 1 in 14; and as 3 died of phthisis, 1 of diarrhœa, and 1 a year after operation, 5 deaths only remain, or a reduced mortality of 1 in 28. *Pirogoff's Amputation.*—Fifty-eight cases of this amputation represent the *whole* number, performed by British Surgeons, of which Mr. Hancock has been able to gather the particulars. Nearly 100 cases, reported by Pirogoff as having been performed in Russia, are not available for statistical comparison. Of the 58 cases, 5 were fatal, or about $9\frac{9}{10}$ per cent. Of the remaining 53 recoveries, in 29 the operation had been resorted to for caries.

(2.) *State of the Foot.*—Of the 32 cases operated on by excision of the ankle-joint, 21 recovered with good useful limbs.

Secondary Amputation, after Ankle-joint *Excision.*—Of the 32 cases, 2 only underwent secondary amputation, and both recovered.

Compared with Secondary Amputations, after *Amputations* of Foot.—(*a.*) After Syme's operation; of the 144 cases submitted for caries, 9 underwent secondary amputation; but of these, 1 was a confirmed drunkard, 1 had been primarily operated on for traumatic gangrene, 1 two years previously for an accident, and in the remaining 2 the disease is not stated. (*b.*) After Pirogoff's operation: of the *whole* 58 (for disease and injury), 5 only suffered secondary amputation, but in 4 of these the primary operation had been performed for caries.

Comparing these two *amputations* of the foot, Mr. Hancock observes, as regards the occurrence of suppuration, the percentage of deaths, of recoveries and periods of recovery, and secondary amputations, the evidence of British Surgery is in favour of Syme's operation; whilst as regards sloughing of the flap, it is decidedly in favour of Pirogoff's proceeding. Syme's amputation appears to be unquestionably the best for *disease*, and Pirogoff's for the accidents of civil life, since by it we preserve an increased length of limb.

Tarsal Bones.—Excision of the Tarsal Bones comprises certain recognized operative procedures, which correspond to the lines of the osseous articulations; as removal of the astragalus, or of the os calcis. But the plan and performance of excisional operations on the foot should not be restricted by these anatomical limitations. The modification of these operations on the foot, according to the kind and extent of the disease, well illustrates the guiding principle of excisional

Surgery; and this application of the general principle I have laid down, is specially advocated by Mr. Hancock, in the Lectures already referred to.

The *conditions of disease* for which excisional operations on the foot may become appropriate, are similar to those which affect other bones and their articulations; namely, the destructive results of inflammation, and especially in the form of caries. According to the extent of such disease, partial or complete excision of any one, or more, tarsal bones may be necessary. I proceed to describe the various operations, and to estimate their value by their results.

(1.) *Excision of Astragalus.—Partial* excision of the astragalus, for disease, was first attempted by Severin in 1646, and in England by Ramsay in 1792. Since that time it has been performed by other Surgeons, but in a comparatively few authentic cases.

Complete Excision.—This operation, as for disease, was first performed by Mr. Busk in 1850. Four other cases only have since been recorded in England; one each by Mr. Erichsen and the late Mr. Statham, and two by Mr. Holmes. An incision along the outer and anterior aspect of the ankle, will expose the bone; its neck should then be severed with strong cutting-pliers; and, some space having been thus made, the bone may be drawn out of its bed by the lion-forceps, the knife being used to detach its ligamentous connections, but applied cautiously towards the inner side of the joint, in proximity to the plantar arteries. It may be necessary to extirpate the bone piecemeal, when its substance breaks down in a carious state; it must then be gouged out.

Some of the *anterior* tarsal bones may have to be removed *with* the astragalus. *Liston's Operation* on the foot—as the excision thus extended, in a noted case, might be named—consisted in the removal of the astragalus, scaphoid, and two cuneiform bones. The case is reported in the "Edinburgh Medical and Surgical Journal" of January, 1821.

Results.—Of *partial* excision of the astragalus, in 27 cases recorded, 8 were operations for disease—caries; 5 terminated well, 1 ended in anchylosis, and in 2 the result was not stated. *Complete Excision.*—In 109 cases of complete excision of the astragalus, 14 were operations for *disease;* 13 being for caries, and 1 for necrosis. Of the 13 cases, 1 died, 8 recovered with good and useful limbs, 2 underwent secondary amputation two years after excision, and both recovered; in 2 the results were doubtful. The case of excision for necrosis did well.

(2.) *Excision of Os Calcis.—Partial* excision seems to have been first performed for injury, in the removal of a musket-ball from the os calcis, by Formius, as long since as the year 1669.

Complete excision was first performed, and for disease—necrosis—by M. Robert, of Prague, in 1837. The second operation, and the first in this country, was by Mr. Hancock, in May, 1848. The first successful case in England was by Mr. Greenhow, of Newcastle, in the same year —1848; and two equally successful cases of complete excision, in the hands of that Surgeon, followed also in that year. Since then, the operation has been practised, with varying success, by other Surgeons; principally, by Sir William Fergusson, Teale of Leeds, Humphry of Cambridge, Cann of Hereford, Pemberton of Birmingham, Potter of Newcastle, Mr. Holmes, Mr. Erichsen, and myself.

The operation is thus performed:—The patient lying on his face, with the sole of the foot uppermost, an incision, with a stout bistoury, may be commenced at the calcaneo-cuboid articulation, just above the sole of the foot, and carried backwards round the heel, forwards, to an equal point on the inner side. The *sole-flap* of integument is raised forwards from the under surface of the os calcis, and in its whole thickness down to the bone, so as to form a good cushion; a slight perpendicular incision is made, opposite the tendo-Achillis, into this horizontal incision, and with a little reflection of the integument to either side, the tendon is severed from its insertion. The knife is then entered posteriorly, over the upper surface of the os calcis, and the strong interosseous ligament connecting it with the astragalus is divided, somewhat as an oyster is opened; the bone can then be raised, and its lateral attachments being cleared by a gentle application of the knife, the calcaneo-cuboid articulation is opened, and the bone completely detached.

Or, an incision may be made, as for Syme's amputation at the ankle-joint, and a *heel-flap* having been formed, the os calcis is exposed; lateral incisions are continued, on either side, along the sole of the foot to the line of the calcaneo-cuboid articulation, whereby a short *sole*-flap is reflected forwards; and the operation completed as before. The objection to this plan of excision is the liability to sloughing of the heel-flap, in disease of the os calcis; fistulous openings frequently having formed posteriorly, where the flap is attached. The advantage of a heel-flap is that the excision can be readily converted into Syme's amputation, in the event of the astragalus being found to be extensively involved. This method, therefore, was recommended by Mr. Teale, and practised by Mr. Page, as a precautionary proceeding in excision of the os calcis.

Apart from the contingency of sloughing, I prefer the sole-flap method of excision, as affording a more free access to the os calcis.

(3.) *Excision of the Os Calcis and Astragalus—Wakley's Operation*—is performed much in the same manner as the second method of excision of the os calcis alone. The only differences are: an *additional* incision between the malleoli posteriorly, curving down to the insertion of the tendo-Achillis, so as to expose the astragalus, on raising this flap of integument; and that the integument of the heel between this incision and the incision across the heel, from malleolus to malleolus, forming the heel-flap in the other operation, is here removed. The bones are excised through the gap thus made posteriorly, by dividing the tendon and lateral ligaments; lateral incisions being continued along the foot to the line of the calcaneo-cuboid and astragalo-scaphoid articulations, so as to give access to these articulations. The malleoli are removed with bone-nippers. The posterior tibial artery must be ligatured, but the anterior tibial is avoided by very cautiously using the knife, in removing the astragalus in front of the tibia.

This excision would probably meet the difficulty of disease extending *up* to the ankle-joint, and, in such case, prove a substitute for Syme's amputation at the ankle-joint. The operation was performed by Mr. Wakley, at the Royal Free Hospital, in December, 1847, and the case is reported in the *Lancet* of July, 1848. But I am not aware that this operation has ever been repeated.

Results.—Of *partial* excision of os calcis, in 42 cases collected by

Mr. Hancock, 38 were operations for *disease;* 25 for caries, 12 for necrosis with sequestra, and 1 necrosis. Of the 25, 1 died the day after operation of diarrhœa, 14 recovered at periods varying from six weeks to six months, 2 required a second operation but recovered, and 1 underwent secondary amputation; while of the remaining 7 the result is not given. Of the 12 cases, 3 recovered, 1 required a second operation, 1 secondary amputation, and of 7 the result is not stated.

Complete Excision.—Of 18 cases—the particulars of which are authenticated—in 14 the disease was scrofulous; and in 11 of these, this condition was entirely constitutional, in 1 it is said to have originated from a nail having been run into the heel, and in 2 to have followed sprains. Of the 11 cases, 1 died of diphtheria, 7 recovered and with perfect use of the limb, while 3 suffered secondary amputation—2 from recurrence of disease in the remaining tarsal bones, and 1 owing to erysipelas. Of the 3 cases induced by injury, 2 recovered completely, and the result of the third was doubtful.

The *general* results of complete excision of the os calcis are thus represented in 34 authenticated cases: 1 died of diphtheria, 25 recovered completely, 4 underwent secondary amputation, and of 4 the results are not given.

In one case of excision of the os calcis, for caries, I removed also the cuboid bone and a small portion of the external cuneiform bone, both of which were involved in the disease. The patient recovered, and with a thoroughly sound and permanently serviceable foot; this result having been established by two years' duration, when the weight of the body could still be supported by the foot, and the ankle-joint had free motion. He walked without the aid of a crutch or stick. The particulars of this case are reported in the *Lancet* of July 23, 1864.

Compared with Sub-Astragaloid Amputation.—This operation has been little practised in England, but chiefly in France. It appears to have been performed altogether in 22 cases, as collected by Mr. Hancock. The results of some are not stated. Of the whole number, 6 were operated on by Malgaigne, 1 by Maisonneuve, and 1 by Nélaton; in 9 collected by Vacquer, all terminated favourably; 1 by Dr. John Traile, of Arbroath, was successful; in 2 by Mr. Simon, one was successful, the other patient died of tetanus at the end of a fortnight; in 1 by Garner, of Stoke-upon-Trent, the report was unfavourable, and 1 by Mr. Hancock was successful.

The *Cuboid*, *Scaphoid*, and three *Cuneiform Bones*, may severally require Excision; and preferably to removal by Chopart's amputation—in the articular line between the os calcis and astragalus behind and the cuboid and scaphoid in front—whereby the two latter tarsal bones, and three cuneiform bones, with the whole of the metatarsus and toes, are sacrificed. But the conditions of disease suitable for excision, rather than amputation, are not determinable by any precise rules; and either operation must be selected according to the judgment of the Surgeon in each particular case.

For the operations of excision, no particular directions can be laid down; the lines of incision must be guided by the state of the integument, and the facility for gaining access to the bone and its articulations.

The Metatarsal Bones may also be excised, either at their articular ends, or by removal of the whole bones. These partial operations are more desirable than the sweeping amputation of the metatarsal portion of the foot, including the toes, by Hey's operation—in the line of the tarso-metatarsal articulations. The choice of operation must here, again, be determined in each particular case by the kind and extent of disease.

The *Toes* are not eligible for excision; except at their articulations occasionally, or of the ungual phalangeal bones. Removal of the intermediate phalanges will scarcely leave a useful toe. With regard to the *great toe*, its metatarso-phalangeal articulation may occasionally be excised, or the last phalangeal bone removed; thus preserving the ball of the toe for the support of the arch of the foot.

But the *results* of these excisions of the metatarsal bones and phalanges of the toes, or of their articulations, are less successful than in the corresponding bones of the hand; the toes or their contracted portions remaining comparatively useless or inconvenient.

Elbow-joint.—This joint appears to be, and certainly in my own experience has been, not unfrequently amenable to treatment without operative interference—in the destructive stage of inflammatory disease, from ulceration of the articular cartilages.

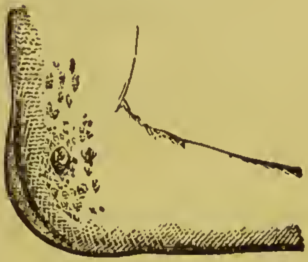
The *natural cure* by anchylosis supervenes more readily, apparently, than in other joints; and fibrous union usually occurring, a movable joint and useful limb is the result.

The following case, which came under my care, is so good an example of this mode of cure, that its history seems worthy of notice. Mrs. P——, aged forty, states (1857) that in 1840, seventeen years ago, a heavy door slamming, struck her left elbow on the outer side. Some pain and swelling followed, which gradually subsided. Pain, however, was felt occasionally after using the arm, during the next six years. Then the forearm gradually became bent on the arm, but the limb could be forcibly straightened. In 1855 she had rheumatic fever; the injured joint was first affected with acute pain and swelling, and other joints subsequently. The swelling of the elbow proceeded to abscess, which broke and discharged matter; leaving seven sinus-openings, of which two in front, and three behind the joint, remained open for the next two years. During ten months of this period, she could not lift her arm to her head, nor feed herself with it. In 1857 the sinuses had all closed, except one which discharged slightly, a little below the head of the radius,—a not uncommon situation of opening in disease of the elbow-joint. The patient's general health remained good; at least, there was no approach to exhaustion. Having regard to the quiescent state of the joint, and the satisfactory state of the constitutional condition, it appeared probable that if sufficient power of nutrition could be evoked, anchylosis would ensue. The result more than fulfilled my anticipation. After three months' treatment, by rest, strapping with the emplastrum ammoniaci cum hydrargyro, tonics and diet—my usual course of treatment for curable joint-disease—fibrous anchylosis had taken place effectually, and there was limited motion in the joint. Improvement gradually continued, and the range of motion increased. In 1861 the patient could roll paste without pain or inconvenience; she could lift a nine-gallon barrel of beer and set it on "thrall," and she could make a bed, shaking the mattress or feather-bed without affecting the elbow. Weather, or the east wind, sometimes gave her slight rheumatic twinges in the joint.

In April, 1865, the joint was neither painful nor swollen; all the sinuses had firmly and permanently closed, leaving the bony outline of the natural articulation only somewhat enlarged and irregular in shape. She could flex the forearm to an acute angle with the arm, and both pronation and supination were perfect. The action of the hand and fingers completed the perfect use of the arm.

The Conditions of Elbow-joint Disease appropriate for Excision.—The three conditions which severally determine the propriety of excision with regard to the joints in general, are applicable to the elbow-joint.

FIG. 509.*

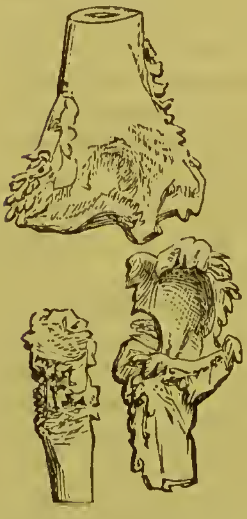


(1.) Functional inutility of the limb, depending on disease of the joint, having resulted in destruction of the articular cartilages, without the supervention of anchylosis, will always justify excision (Fig. 509); care being taken that the constitutional condition shall *not*, if possible, have approached to exhaustion. But the degree of reserve-power requisite for recovery is much less than after excision of the knee or hip, owing to the average period of reparation being less by one-half, or about six weeks instead of at least three months.

(2.) Osseous anchylosis, and particularly in connection with a useless position of the limb, will also justify excision.

(3.) The structural conditions of disease pertaining to the elbow-joint, which specially affect the propriety of its excision, relate to the *extent of bone* destroyed by disease. The limits of excision of the elbow-joint are not restricted by two of the three considerations respecting the knee-joint. Thus, the length of the portions of bone removed from the elbow is comparatively unimportant, the corresponding loss of length in the arm not much impairing the use of this member eventually; nor is it of consequence, therefore, to observe the epiphyseal lines as affecting the subsequent growth of the bones. But it is equally requisite in the elbow, as in the knee, to preserve sufficiently wide surfaces for the formation of an adequately secure union: in the one case, with ligamentous mobility; in the other, with osseous consolidation.

FIG. 510.†



The removal of only a thin superficial section of the articular ends of the bones in the elbow-joint, leaving the section ends too nearly in contact, is apt to be followed by osseous union and an unsuccessful result of the operation. On the other hand, any new bone which may not unfrequently have been produced in the form of a spiculated enlargement of the articular ends *above* their diseased portions, and thereby limiting the disease, should not be included in the excision. (Fig. 510.) The importance of observing this limitation of the operation is particularly urged by Mr. Butcher in his work on "Operative and Conservative Surgery."

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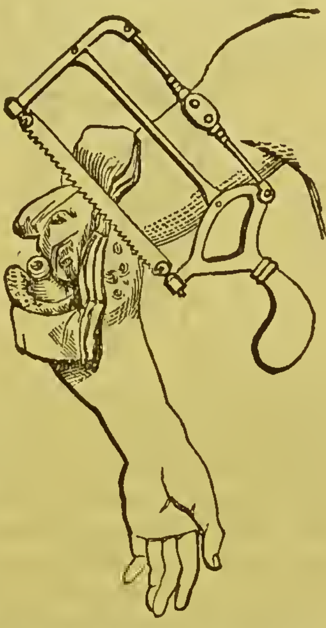
* Royal Free Hospital. (Author.)

† St. Bartholomew's Hosp. Mus., 2, 30.

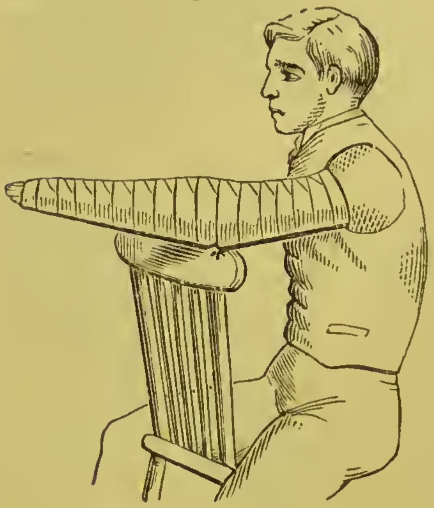
Operation.—Excision of the elbow-joint, for disease, was originally performed by Justamond, of the Westminster Hospital, in 1775,—as a partial operation, in which the olecranon and two inches of the ulna were removed; complete excision was first performed by Moreau, senior, in 1794, and by Moreau, junior, in 1797; but the operation attracted little attention until it was revived by Stansfield, Chorley, and Hey, of Leeds, in 1818–19; and especially by Syme in 1830; since which period it has been more generally practised than the excision of any other joint for disease.

Fig. 511.



The operation is thus performed:—a single linear incision |, longitudinally over the centre of the joint, and of sufficient length to turn out the bones, is preferable to any other, in relation to a speedy recovery after operation. Other forms of incision offer certain special operative advantages. An H shape exposes the bones more readily, on reflecting the flaps, thus marked out, upwards and downwards. (Fig. 511.) A ⊣-shaped incision, with the vertical line parallel to and a little outside the ulnar nerve, allows of its being more surely guarded or drawn inwards, by a curved retractor in the hands of an assistant. In either case, the transverse lines of these incisions should be made across the end of the olecranon from condyle to condyle; or nearly to the inner condyle, in the latter form of incision; and thus the joint is laid open. But the single longitudinal incision is now, I believe, generally practised, and I rarely find any other more convenient. With a little detachment of the integument on either side, the knife is entered transversely above the olecranon, dividing the tendon of the triceps,—the ulnar nerve being protected; the olecranon process must then be sawn off transversely, and by forcibly flexing the arm and, perhaps, dividing the lateral ligaments with a light touch of the knife, the articular surfaces of the three bones are fully protruded and exposed. Mr. Maunder has shown the importance of preserving the structures between the external condyle and the olecranon, consisting of the outer portion of the triceps with its tendinous prolongation, the fascia, and the anconeus muscle, forming a continuous band; whereby active extension of the forearm may be secured. The articular surface of the humerus, between the condyles, is excised by means of Butcher's saw (see Fig. 511); and the sigmoid surface of the ulna and head of the radius, in like manner, or removed with pliers, or simply gouged. The latter two bones should not be removed below the insertions of the brachialis anticus and biceps muscles; for thus the brachial artery will be protected by the intervening brachialis muscle from any fair risk of injury, in removing these portions of bone; and, by preserving the insertions of both muscles, the voluntary flexion of the elbow, eventually, is rendered far more complete. When requisite, a more extensive excision may be made, by applying the saw above the condyles of the humerus across the olecranon fossa; and below, just beneath the lesser sigmoid cavity of the ulna, including the head of the radius at that line. Any surrounding *outgrowth* of bone, resulting from exuberant reparative action, must not be mistaken for disease; it should not be included in the excision. But any thickened synovial membrane may be dissected out. The line of incision having been closed with sutures, the arm is placed semiflexed on an angular splint (Fig. 512); or it may be simply laid upon a pillow, with a sand-bag on either side of the forearm, just to steady the part. This plan of after-treatment, without any splint, was, I believe, first tried in my own practice. It offers the advantage of being attended with less swelling and tension around the elbow, than when a splint is used, with an interrupted bandage; and union, therefore, progresses more favourably. To insure the formation of fibrous or flexible union only, passive motion should be gradually commenced when such reparation is established; say, in three or four weeks.

Fig. 512.*



Results of Excision of Elbow-joint.—(1.) In relation to Life, or the *Mortality*.—Three *general* conclusions may be drawn from the results of one large collection of cases; those in the Hospitals of the United Kingdom, and the practice of individual Surgeons. (1.) A less mortality than that of any joint-excision in the lower extremity; and in the upper extremity also, so far as statistics hitherto collected supply the data for comparison. (2.) An average mortality of 1 in 8, or 12 per cent.; or even much lower,—about 1 in 15, or about 7 per cent. (3.) A very different mortality in the hands of individual Surgeons.

The collection of cases, by Dr. Hodges, amounts to 119; of these, 15 died, 1 in 8, or 12 per cent.

Author's Collection.

(1.) Royal Infirmary, Edinburgh; period. 1865-69. (Per Mr. P. H. Watson.) Number of cases, 62: recoveries, 50; deaths, 12.

(2.) Liverpool Royal Infirmary; period, five years, 1870. (Per Mr W. J. Cleaver.) Number of cases, 30: recoveries, 29; deaths, 1; amputations after excision, 1; recoveries, 1.

(3.) St. Bartholomew's Hospital; period, 1866-70. (Per Mr. Callender.) Number of cases, 19: recoveries, 17; deaths, 2; amputations after excision, 2; recoveries, 1; deaths, 1.

(4.) Guy's Hospital; period, 1864-69. (Per Mr. T. Bryant, from Dr. Steel, superintendent.) Number of cases, 19: recoveries, 17; deaths, 2.

(5.) Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per Mr. P. H. Watson.) Number of cases, 15: recoveries, 14; deaths, 1; re-excisions, 1; recoveries, 1.

(6.) London Hospital; period, five years, 1870. (Per Mr. McCarthy.) Number of cases, 14: recoveries, 12; deaths, 2.

(7.) King's College Hospital; period, five years, 1870. (Per the house surgeon.) Number of cases, 12: recoveries, 11; deaths, 1.

(8.) Westminster Hospital; period, five years, 1870. (Per Mr. F. Mason.) Number of cases, 12: recoveries, 12.

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* Royal Free Hospital. Patient convalescent.

(9.) Charing Cross Hospital; period, 1860–65. (Per Mr. Hancock.) Number of cases, 8: recoveries, 8.

(10.) St. Mary's Hospital; period, five years, 1870. (Per Mr. Gascoyen.) Number of cases, 8: recoveries, 8.

(11.) Royal Free Hospital; period, seven years, 1870. Number of cases, 7: recoveries, 6; deaths, 1.

(12.) Royal Sea-Bathing Infirmary, Margate; period, five years, 1870. (Per Mr. J. R. Clouting.) Number of cases, 6: recoveries, 6; re-excisions, 2; recoveries, 2.

(13.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 4: recoveries, 4.

(14.) Royal Albert Hospital, Devonport; period, five years, 1870. (Per Mr. W. P. Swain.) Number of cases, 2: recoveries, 2.

(15.) Great Northern Hospital; period, five years, 1870. (Per Mr. J. Willis.) Number of cases, 1: recoveries, 1.

Compared with Mortality of Amputation of the Arm.—By Malgaigne's statistics from the Parisian Hospitals we find, of sixty-one cases for disease, four deaths resulting, or 6·5 per cent;—a *lower* mortality than that after excision of the elbow-joint. But the statistical results from University College Hospital, furnished by Mr. Erichsen, show a *far higher* mortality after amputation. Of eighteen cases of amputation of the *shoulder* and arm for disease, five died, or 27·7 per cent.

(2.) *State of the Limb.*—Of the 104 recoveries out of 119 cases, the majority (*minus* fifteen amputation cases) had useful limbs, as proved by the patient being able to resume his ordinary avocations; but the details given respecting the kind and extent of motions left are not exact.

The *average duration* of the process of recovery cannot be gathered from recorded cases. In three or four weeks generally, passive motion may be commenced, and fibrous union be completed in about six weeks; a more rapid progress by half the average period requisite for *osseous* union, after excision of the corresponding joint in the lower limb—the knee.

The resulting *state of the joint* is commonly fibrous and flexible union, rarely osseous and fixed anchylosis; the former, of course, being the result desired. In an interesting case, which Mr. Syme had the opportunity of dissecting nine years after the operation of excision of the elbow, for injury, the ulna was found united to the humerus by ligament, while the end of the radius was polished off, and played on the humerus and ulna, a material like cartilage being interposed. The ends of the bones of the forearm were locked in by two processes projecting downwards from the humerus, and strong lateral, and still stronger anterior and posterior ligaments, also bound them to the latter bone. Dissections of several cases, after successful excision of the elbow, may be found in Wagner on "Repair after Re-section;" and it would seem that the general result is,—union by more or less extensible ligament. Flexion, according to M. Robert, is composed of two movements; the forearm being first drawn up to the humerus by the triceps, and then flexed by the action of the biceps. The joint becomes nearly as useful as the original articulation. Thus, in Mr. Syme's case, the man—a railway guard—could swing himself from one carriage to another while the train was in motion, with the injured arm, quite as easily and securely as with the other; and in one of Mr. Butcher's cases, the man could lift a bucket of water, holding four gallons, and carry it to and fro, or lift it on to a table three feet high. Then again, the freedom of the anchylosis for the more delicate movements of the forearm and hand, was well exhibited in one of my own cases (Case 1); a milliner and dressmaker who could work with her needle readily and untiringly,—a seven years' permanent result of excision.

Injury of the ulnar nerve—an occasional accident during the operation—is followed by loss of sensation in the little finger and adjoining side of the ring finger, with perhaps loss of motion and wasting of the finger; but the sense of touch may return, and the other ill consequences cease, apparently by reunion of the wounded nerve. This accident, judging from the digital paralysis, happened in one of my own cases,—that of the milliner just mentioned; but the symptoms passed off entirely, as the functional use of the finger showed.

Re-excision may be practised—as in the knee—when necessary, rather than resort to amputation; and even a third such attempt has, it is said, been made with good results. In my table of Hospitals, 219 cases; of the 197 recoveries from the primary excision, three only are noted as having undergone re-excision, but with no death. Of my own cases, in the first five I had to re-excise one, and with a thoroughly successful result,—the patient resuming his occupation as a postman.

Secondary Amputation.—Of the 104 recoveries after excision, in Hodges' collection of 119 cases, fifteen of that number underwent amputation subsequently. From the collection of Hospitals, we learn that, of the 197 recoveries, three only were subjected to amputation, with one fatal issue.

The following cases in which I excised the elbow-joint, for disease, are here grouped together, as exhibiting the most essential particulars relating to the question of this operation; and the permanent results are also stated. The notes from which I have drawn up these abstracts were carefully taken, excepting in the first case, by Mr. T. C. Murphy, formerly senior house surgeon at the Royal Free Hospital.

TYPICAL CASES OF ELBOW-JOINT EXCISION. — CASE 1. — Margaret R——, æt. 25. *Chronic synovitis*, of traumatic origin, one and a half year's duration, one year and two months' treatment. *Partial ulceration* of the articular cartilages of the humerus, ulna, and radius; with semiflexed position of the limb. *Excision. Recovery*, with a movable joint and useful limb, in six weeks. *Result known to be permanent after* seven years.

For the particulars of this case I am indebted to my late colleague, Mr. John D. Hill, then senior house surgeon in the Hospital.

CASE 2.—Thomas H. B——, æt. 29. *Chronic synovitis*, of traumatic origin, one year's duration and treatment. *Ulceration* of the *articular cartilages* of the humerus, ulna, and radius; with semiflexed position of the limb. *Excision. Recovery*, with a partially movable joint. Subsequent formation of abscess and sinuses. *Re-excision. Recovery*, with a movable joint and a limb useful, in flexion, extension, pronation, and supination. *Result known to be permanent after* one year and four months.

CASE 3.—Mary M——, æt. 28. *Acute synovitis*, of traumatic origin, one month's duration. *Partial ulceration* of the *articular cartilages* of the humerus, ulna, and radius, with subjacent *caries;* a semiflexed position of the limb; *excessive* and *paroxysmal pain. Excision. Recovery*, with a movable joint by passive motion, in six weeks. *Result known to be permanent after* one year.

CASE 4.—Jane T——, æt. 31. *Scrofulous caries* of the ends of the humerus and ulna in the elbow-joint. *Ulceration* of the *articular cartilages*, with semiflexed position of the limb. *Excision*. *Recovery*, with a partially movable joint by passive motion, in two months. *Permanent* result, at the end of six months, uncertain.

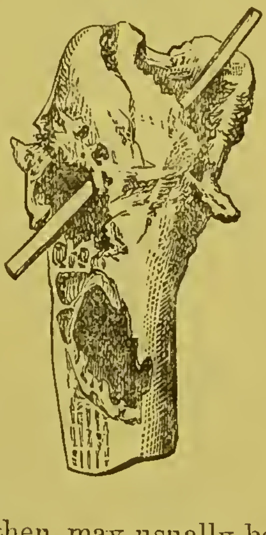
Case 5.—Lewis P——, æt. 50. *Caries* of the olecranon, of idiopathic origin, ten months' duration and treatment; idiopathic abscess opposite the outer condyle of the humerus, six years previously. Carious bone gouged out of the olecranon. The joint opened in this procedure. *Excision* of the olecranon and of the end of humerus. *Recovery*, with a movable joint.

Shoulder-joint.—Disease of the shoulder-joint occurs so much less frequently than that of other joints, as to considerably restrict the opportunities for clinical observation respecting its seat of origin, the probability of natural anchylosis ensuing, or the necessity for operative interference by excision to bring about that issue. The synovial membrane, in some cases, would appear to be the seat of the disease; and then, suppuration being a rare event, fibrous anchylosis usually results. But caries, in other cases, is the mode of origin,—affecting the head of the humerus, less commonly the glenoid cavity, or only secondarily and partially; and then natural anchylosis rarely takes place. Caries, external to the joint, as of the coracoid process, the acromion, or spine of the scapula, must not be confounded with disease of the shoulder-joint.

Thus may be recognized as indications for operation the following. *Conditions of Shoulder-joint Disease appropriate for Excision*:—

(1.) When disease, commencing either in the synovial membrane, or as caries, has extended to and destroyed the articular cartilages of the head of the humerus, or of the glenoid cavity of the scapula, or of both surfaces; without the supervention of anchylosis. The constitutional condition should not have advanced to exhaustion; although, in even an extreme state of hectic and emaciation, recovery after excision of the shoulder-joint is more probable than after such operation on any other large joint.

Fig. 513.*



Necrosis or caries of the head of the humerus generally necessitates excision of this portion of bone (Fig. 513); but sometimes, in central necrosis, the sequestrum can be extracted, without excision. Caries or necrosis of the coracoid process, or of the acromion, is, of course, a condition of disease not requiring excision of the joint.

(2.) Osseous anchylosis, a rare condition, with perhaps malposition of the limb, would scarcely ever justify the risk of excision.

The *amount of bone* to be removed is rarely extensive; the disease being limited usually to the head of the humerus, while the glenoid cavity is comparatively seldom affected, and even then may usually be left untouched, or only scraped.

Operation.—Excision of the shoulder-joint, for disease, is commonly said to have been originated by Mr. Charles White, of Manchester, in April, 1768. He had previously removed the head of the humerus on the dead subject; but the operation in question consisted in removing the upper part of the humerus for necrosis, leaving the head of the bone in the glenoid cavity. Similar excisions were performed by Vigaroux, of Montpellier, in 1767, and perhaps by David, of Rouen. Ridewald, in April, 1770, appears to have first removed the head of the humerus, for arthritic disease, the patient being a man, fifty years old, in a wretched condition of health; secondary amputation was resorted to for suppuration and hæmorrhage, and death ensued. This operation was followed in the next year, 1771, by another case; Mr. James Bent, of Newcastle, excised the head of the humerus for caries, of three years' standing, and with entire success. In the same year, the operation was performed by Leutin; then, in 1778, by Mr. Daniel Orred, of Chester; and in 1786, by the elder Moreau,—a complete excision of the head of the humerus, the glenoid cavity, and a portion of the acromion; the result being successful. Mr. Syme revived the operation in 1826.

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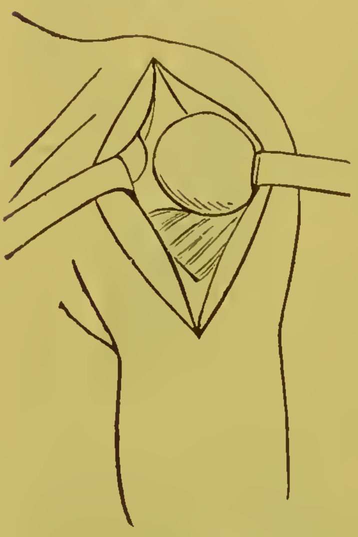
* St. Thomas's Hospital Mus. Caries of the head of the humerus. Excision. (Dr. Mackellar.)

An elliptical incision, U, exposes the joint most thoroughly for examination, and facilitates the application of instruments; but, by severing the deltoid muscle, at the turn of the incision, the voluntary abduction of the arm, subsequently, is much impaired. A single longitudinal incision is nearly as effectual, and avoids the after-disadvantage referred to; or a ┐ or a ⊤ incision may be preferable; and, in truth, the shape of the flap must be guided by the state of the integument with regard to sinuses or otherwise. Supposing an elliptical to be selected:—A bistoury is entered at the posterior border of the acromion, and carried down with a sweep across the insertion of the deltoid, upwards to the inner border of the coracoid process. The flap, embracing the deltoid muscle, is raised by a few touches with the knife; then, the external rotator tendons are divided, by running the blade across the great tuberosity of the humerus; and, by slight adduction and rotation of the arm outwards, the tendon of the subscapularis, attached to the small tuberosity, is touched with the knife, and thus the head of the humerus is turned out of the glenoid cavity,—the capsular ligament having disappeared. Or, the single linear incision may be made on the inner aspect of the joint, between the acromion and coracoid processes of the scapula, where the head of the humerus is most prominent. The head of the bone is then exposed, and presented in like manner; the soft parts being well retracted by an assistant with a curved retractor on either side, while just freeing the muscular attachments. (Fig. 514.) Then, protecting the soft parts and long tendon of the biceps with a spatula on the inner aspect of the bone, the saw is applied below the diseased portion. The head, neck, and proximate part of the shaft may be thus removed: avoiding,

FIG. 514.



if possible, the circumflex arteries. Any carious portion of the glenoid cavity may be scraped with a gouge. As a rule, with very rare exceptions, the glenoid cavity should not be excised. The flap is replaced, or the linear incision closed, and retained by sutures; and the arm, with an axillary pad, may be bound to the chest, as for fractured clavicle; or supported on a pillow, extending as a splint from the axilla. Subsequently, the forearm must be supported in a sling, and the arm gradually brought into useful motion.

Results of Excision of the Shoulder-joint.—(1.) In relation to Life, or the *Mortality.*—Statistics are not, at present, sufficiently comprehensive to establish more than one general conclusion respecting this question. The average mortality appears to be 1 in 5, or 6; 20 per cent., or about 16 per cent., respectively. Of 50 cases, collected by Dr. Hodges, 8 died; 1 in 6, or about 16 per cent.; and in 7 of the 8 fatal cases, the glenoid cavity had been interfered with. Of the 30 cases in the Hospital collection below, the death-rate was nearly 1 in 4, or 25 per cent.

Author's Collection.

(1.) Royal Infirmary, Edinburgh; period, 1865–69. (Per Mr. P. H. Watson.) Number of cases, 10: recoveries, 7; deaths, 3.

(2.) Liverpool Royal Infirmary; period, five years, 1870. (Per Mr. W. J. Cleaver.) Number of cases, 7: recoveries, 6; deaths, 1.

(3.) London Hospital; period, five years, 1870. (Per Mr. J. McCarthy.) Number of cases, 3: recoveries, 1; deaths, 2.

(4.) Westminster Hospital; period, five years, 1870. (Per Mr. F. Mason.) Number of cases, 3: recoveries, 3.

(5.) St. Bartholomew's Hospital; period, 1866–70. (Per Mr. Callender.) Number of cases, 2: recoveries, 1; deaths, 1.

(6.) Guy's Hospital; period, 1864–69. (Per Mr. T. Bryant, from Dr. Steel, superintendent.) Number of cases, 2: recoveries, 2.

(7.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 1: recoveries, 1.

(8.) Charing Cross Hospital; period, 1865–70. (Per Mr. Hancock.) Number of cases, 1: recoveries, 1.

(9.) Royal Free Hospital; period, 1865–70. Number of cases, 1: recoveries, 1.

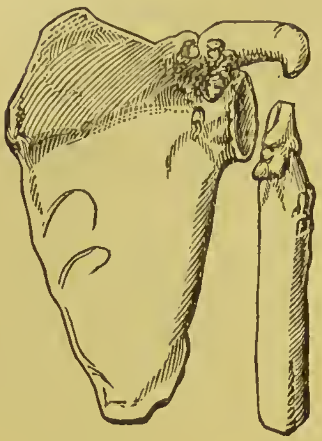
(10.) King's College Hospital; St. Mary's Hospital; Great Northern Hospital; Royal Albert Hospital, Devonport; Chalmers' Hospital, Edinburgh; Royal Sea-Bathing Infirmary, Margate; period, each five years, 1870. No cases.

(2.) *State of the Limb.*—In four of the fifty cases collected by Hodges, the operation was unsuccessful; leaving a balance of forty-six successful cases.

The *average period of recovery*, with some use of the limb, as calculated from thirty-one of the cases, was four months; "a much longer period, however, than this elapsed, before the limb could be said to become really serviceable."

The resulting state of the joint would seem to be, that the limb can never be elevated above the horizontal line, while in many cases it hangs down without any power whatever in the deltoid, at a greater or less distance from the scapula. But the movements of flexion, extension, and adduction are usually free; abduction can often be effected to the extent of raising the arm considerably from the side; and there is generally sufficient power in the *forearm* to carry heavy weights, and perform many of the ordinary domestic tasks. The arm is, therefore, a very useful one, irrespective of the vast importance of preserving the *hand*, and thus the person is enabled to follow many of the ordinary trades. I have succeeded in finding, among the pathological collections in London, one specimen, in which a complete new articulation having formed after excision of the shoulder-joint, this result had stood the test of twenty years' service. (Fig. 515.)

FIG. 515.*



The following cases well illustrate the successful results of shoulder-joint excision, for disease. I have narrated the first case from careful clinical notes by Mr. T. C. Murphy.

CASE 1.—John C——, æt. 21; admitted into the Royal Free Hospital, July 30th, 1870. The patient, of naturally good constitution, had never suffered from rheumatism; but for the last two years he had habitually drank hard. At about the commencement of that period he was struck with a stick on the right shoulder; three months afterwards, a small abscess formed at the anterior margin of the axilla. It was opened, and has continued to discharge ever since. The arm gradually became more fixed and drawn to the side. In the course of six months, a large abscess, the size of a fist, formed under the spine of the scapula; this was opened at St. Bartholomew's Hospital. Other abscesses have since formed; so that, on admission, the shoulder presented considerable enlargement, and seven sinus-openings—three posteriorly, two externally through the deltoid muscle, and two anteriorly in the angle of the axilla. From the date of injury up to the present time, the joint has been painless, unless the arm was forcibly moved. The general health is much reduced by the profuse and long-continued discharge. I therefore endeavoured to restore the patient, as far as possible, constitutionally and locally, by a sustaining diet and rest of the joint; and, as he retrogressed occasionally, from attacks of diarrhœa, I postponed interference, watching the most favourable opportunity for operation. At length, after two months and a half of this manœuvring, on October 15th, I excised the joint; performing the operation by the elliptical incision, so as to embrace and raise the deltoid muscle, thus to thoroughly expose the whole joint. The remnant head of the humerus was sawn through below the great tuberosity; observing my usual precaution, in all joint-excisions, not to detach the vascular connection of the surrounding integument, and making the section just level with its attachment. The glenoid cavity, denuded of cartilage, was slightly scraped and freshened with a gouge. Torsion of one or two small vessels, and one ligature, sufficed to arrest the trifling hæmorrhage. The flap being laid down, and closed by a few points of suture, no retentive splint was applied; an axillary pad, and a bandage as for fractured clavicle, kept the osseous surfaces in apposition, and the arm on the chest. The wound healed throughout by primary union, discharging only from its angles, while the sinus-openings gradually dried up. The result, at the end of about six weeks, was a freely movable joint in all directions—circumduction and rotation; with power to perform these movements, but only to a limited extent that of raising the arm by abduction horizontally. The general health had so far improved that, regaining some flesh and strength, the patient became cheerful, and said "he felt better than he had done for years." He left his bed daily. Subsequently, however, attacks of diarrhœa recurred from time to time, and the abdomen became tumid and tympanitic; enlargement of the liver, assumed to arise from amyloid or albuminous degeneration, was diagnosed by my colleague, Dr. Cockle, under whose care the patient remained. He died from this organic disease on February 4th, three and a half months after the operation, from which he had entirely recovered, and with a freely movable joint. P.-M. examination verified the diagnosis, and the articulation was a perfect specimen of a new ball-and-socket joint; an entire capsular ligament had formed, and the section end of the humerus moved freely on the glenoid cavity of the scapula—in circumduction and rotation.

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* Roy. Coll. Surg. Mus., 923D.

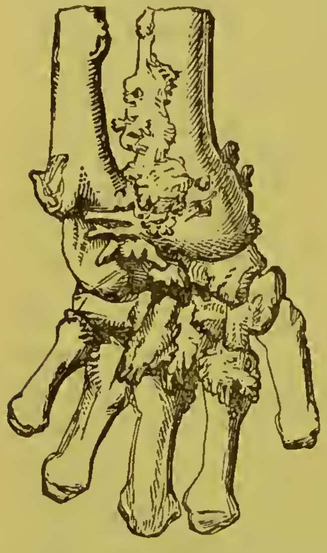
Case 2.—E. F——, æt. 17, a young lady, the daughter of a practitioner well known in this metropolis. I was invited by him (January, 1871) to witness the result in this case, and I am thus enabled of my knowledge to speak to its perfect and permanent success; at the same time, he communicated the following important particulars to me respecting its history:—Six years ago, when this young lady was between ten and eleven years of age, she apparently took cold, while resting on a seat in Hyde Park. Her previous health having been always good, and as she had never received any injury to the shoulder, this was the only assignable cause of what took place. The right shoulder-joint became very painful, and acute inflammation set in, followed by free suppuration in forty-eight hours. Dr. Sibson saw the case, and then, by his recommendation, Mr. Samuel Lane, who immediately opened the abscess. It continued to discharge copiously, for two months; so abundantly, indeed, that the father, who measured with a half-ounce spoon the quantity of matter discharged from day to day, thus calculated that the patient lost, during this short period, three gallons of pus. Her constitutional condition, accordingly, was much reduced. Then, two months from the date of apparent origin, Mr. Lane excised the shoulder-joint, assisted by Mr. James Lane and Mr. Gascoyen, Mr. Pollock and the father also being present. A longitudinal incision was made on the front of the humerus, apparently at the inner border of the deltoid muscle, from opposite the coracoid process downwards to about three inches in extent, and a short transverse cut superiorly; forming a ⊤-shaped incision. Two inches and a half of the humerus were removed, and the glenoid cavity, in a deeply carious state, was freely gouged. The patient made an uninterrupted recovery; as reparation took place, the appetite became voracious, and assimilation equally active. Nourishing food —meat, eggs, milk, with port wine, champagne, porter, etc., were taken eagerly at frequent intervals, by day, and even in the night. Being naturally intelligent, she declined any tonic medicine, as she felt her flesh and strength returning; her suggestive remark being—"Which do you think will do me the most good, that which I like, or what I don't like?" The voice of Nature, thus proclaimed by Nature's child, was heeded. She made a complete recovery, and the result is—that, although the arm is four inches shorter than its fellow, she moves it freely backwards and forwards, without, however, the power to raise it horizontally, unless aided by the left hand. The motions of the forearm are perfect, so that she can work readily, write, or play the piano. The limb is, therefore, a most useful one, and this result has now been permanently established by thirteen years' service (1878).

WRIST.—Excision of the wrist comprises, properly speaking, not only the removal of the articulatory portions forming the radio-carpal articulation or wrist-joint, but also the carpus, and bases of the metacarpal bones; this extent of excision differing from that of the analogous operation on the ankle-joint, which is restricted to the removal of the articulatory portions of the tibia and fibula with that of the astragalus.

Conditions of Wrist-disease appropriate for Excision.—Partial or *complete* disease of the wrist cannot be referred, like that of the larger and more simple joints, to an independent origin, either in the synovial membranes, three in number, or in the bones of the wrist. The lower articular end of the radius, and that of the ulna, which in relation to excision is associated with the wrist; the carpus below, consisting of eight bones, in two ranges of four in each; and the bases of the five metacarpal bones; are all so contiguous, as to obscure the precise seat of origin in caries affecting the wrist. Then again, the three synovial membranes are as one, in relation to the origin of disease in the form of synovitis;—the membranous investment of the radio-carpal articulation, which sometimes communicates with that of the radio-ulnar articulation through a perforation in the intervening triangular fibro-cartilage; the investment between the two ranges of carpal bones, with its two prolongations upwards, and sometimes extending into the synovial membrane of the radio-carpal articulation, and the three prolongations downwards which always extend to and invest the four inner carpo-metacarpal articulations; and the separate synovial sac for this articulation in the thumb.

Caries of the wrist appears to be generally of scrofulous, and thence constitutional, origin—excited perhaps by some injury, of apparently trifling character, as a sprain; while synovitis seems to have another constitutional origin, probably as chronic rheumatism.

FIG. 516.*



Thus, we recognize as conditions of disease for excision :—

(1.) Scrofulous caries of the wrist; often involving the lower articular ends of the radius and ulna, the whole of the carpal bones, and the bases of the metacarpal bones, in a state of extensive caries.

(2.) Chronic synovitis, of perhaps more limited extent, but leading to caries and destruction of the articulations. (Fig. 516.) In the specimen here figured, rheumatic arthritis had produced the usual ossific deposit around the joints affected.

The *amount of bone* to be removed, as being apparently diseased, may vary according to the character and extent of the disease. Thus, excision might include the lower ends of the radius and ulna, with the adjoining carpal bones,—in the wrist-joint; or the bases of some or all of the metacarpal bones. But Professor Lister insists on the complete extirpation of the wrist, in *all* cases,—from the lower ends of the radius and ulna to the bases of the five metacarpal bones, inclusive; the disease, however limited it may appear, being apt to recur in the articulatory portions left by a partial operation.

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* St. Bartholomew's Hosp. Mus., 2, 23.

Operation.—Excision of the wrist was originally performed by the younger Moreau, at the close of the last century; subsequently, by a German Surgeon, Dietz, in 1839; and then again by Heyfelder, of Erlangen, in 1849; but in this country the operation was revived by Sir William Fergusson, in August, 1851. Since that period, it has been resorted to by Mr. Simon, Mr. Erichsen, the late Mr. Stanley, and Mr. Butcher, of Dublin; and practised especially by Professor Lister, who has devised a particular method of operation,—for complete excision of the wrist.

Partial excision consists in the removal of only one or two of the carpal bones, or other limited portions of the bones, forming the wrist. This procedure can be readily effected by slitting up any fistulous aperture leading to the carious bone, and extracting it by bone-nippers and forceps.

Complete excision may be performed in either of three ways. The choice of method is mainly determined by the consideration of difficulty in removing the affected bones, without dividing the extensor tendons of the fingers and thumb; the supinator tendon, radial and ulnar extensor tendons inserted into the bases of the metacarpal bones, being comparatively unimportant, in consequence of the firm fibrous anchylosis of the wrist after operation, if the result be successful.

First method.—A curvilinear incision is made, extending from just above the styloid process of the radius, downwards across the back of the wrist, and upwards to the same level above the styloid process of the ulna; the flap of integument is reflected, *carefully* avoiding the extensor tendons of the fingers, and those of the thumb, on the ulnar half and external border of the radius. Then, dividing the supinator tendon, and the two extensor tendons of the carpus, and flexing the wrist, the radio-carpal articulation is opened; and, while the other extensor tendons referred to are drawn aside with a curved retractor by an assistant, the articular ends of the radius and ulna, the carpal bones, and bases of the metacarpus, are successively removed by a small saw or cutting-pliers introduced transversely.

Second method.—Two *lateral* longitudinal incisions are made, one on the ulnar, the other on the radial, side of the wrist; thus *readily* avoiding the extensor tendons of the fingers, and that of the second joint of the thumb. The operation is then continued as before, and completed by excising the bones in the same manner.

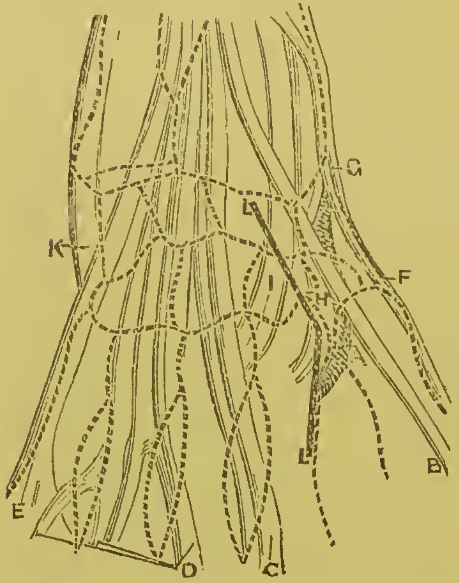
A *single ulnar* incision is deemed sufficient by Sir W. Fergusson, and as the best mode of operation. But this does not allow of easily getting at the large articular end of the radius.

Professor Lister has particularly pointed out that there are two obvious and important objections to the lateral method, which somewhat resembles that which he has devised. Firstly, the radial incision is so placed, as probably to sacrifice the extensor tendon of the metacarpal bone, and that of the second joint, of the thumb. Secondly, with regard to the bones, that in dividing them, an unnecessarily large amount of bone is removed from the radius and ulna, and from the metacarpus,—a loss of length and breadth which interrupts the process of consolidation, and results in a more narrow wrist and impaired strength of the hand. Moreover, that the bones being divided *in situ*, some portion of the disease may probably be left behind.

To obviate these difficulties in performing the excision, and to avoid the tendons requisite for the efficient use of the hand and fingers, another method of operation has been proposed and practised by Professor Lister. It consists in two essential peculiarities:—the *radial* incision is so placed, on the dorsal aspect of the radius, as to avoid the tendons which are otherwise liable to be implicated—the extensor ossis metacarpi pollicis, and the extensor secundi internodii; while the limited, but complete, excision of the bones is accomplished by first removing the *carpus*, and then the articular ends of the radius and ulna, and the bases of the five metacarpal bones. This procedure is confessedly complicated in its detail—"consisting of a series of operations, each one of which must be executed with scrupulous care," and it demands accurate anatomical knowledge—an objection of no reasonable weight; the operation is also tedious to the Surgeon in its performance, and protracted for the endurance of the patient even under the influence of chloroform. These apparent objections, as to the nature of the operation itself and its performance, would, however, seem to be entirely overruled by its more *successful* results, as compared with the simple procedures already noticed.

Third method, or Lister's Operation.—Chloroform having been administered, a tourniquet is placed upon the limb to prevent oozing of blood, which would interfere with the careful scrutiny to which the bones must be subjected. Any adhesions of the tendons are thoroughly broken down by freely moving all the articulations of the hand. The radial incision is then made. (Fig. 517.) It commences above at the middle of the *dorsal* aspect of the radius, on a level with the styloid process, this being as close to the *angle* where the tendons of the secundi internodii pollicis and indicator meet, as it is safe to go. At first, it is directed towards the inner side of the metacarpo-phalangeal articulation of the thumb, running parallel to the tendon of the extensor secundi internodii; but, on reaching the line of the radial border of the metacarpal bone of the forefinger, it is carried downwards longitudinally for half the length of that bone, thus avoiding the radial artery, which lies somewhat to the outer side. These directions will be

FIG. 517.*



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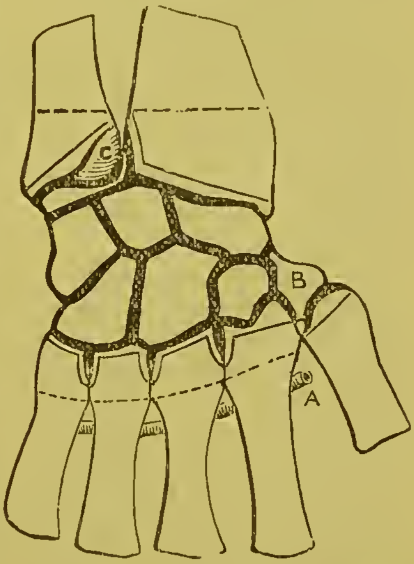
* Diagram of parts concerned, and radial incision, in excision of the wrist.—A, radial artery; B, extensor secundii internodii pollicis; C, indicator; D, extensor communis digitorum; E, extensor minimi digiti; F, extensor primi internodii pollicis; G, extensor ossis metacarpi pollicis; H, extensor carpi radialis longior; I, extensor carpi radialis brevior; K, extensor carpi ulnaris; L, L, radial incision. (Lister.)

found to serve, however much the parts may be obscured by inflammatory thickening. Next, the soft parts at the *radial* side of the incision are detached from the bones with the knife, guided by the thumb-nail; so as to divide the tendon of the extensor carpi radialis longior at its insertion into the base of the second metacarpal bone, and raise it, along with that of the extensor carpi radialis brevior previously cut across, and the extensor secundi internodii, while the radial artery is thrust somewhat outwards. Then, the *trapezium* is detached from the rest of the carpus, by means of cutting-pliers applied in a line with the longitudinal part of the incision, but the removal of this bone is postponed until the rest of the carpus has been taken away, when it can be dissected out without much difficulty; the one procedure also not endangering the radial artery, the other having that risk. The soft parts on the *ulnar* side of the incision are dissected up from the carpus as far as may be convenient, the remainder being raised by the second or ulnar incision.

This incision, a free one, should commence at least two inches above the end of the ulna, immediately *anterior* to the bone; it is carried down between it and the flexor carpi ulnaris, and onwards in a straight line to the middle of the fifth metacarpal bone at its palmar aspect. The *dorsal* lip of this incision is raised, and the tendon of the extensor carpi ulnaris is cut at its insertion into the base of the fifth metacarpal bone, and is dissected up from its groove in the ulna, without isolating it from the integuments, which would endanger its vitality. Then the extensor tendons of the fingers are readily separated from the carpus, the hand being bent back to relax them, and the *dorsal* and *internal lateral ligaments* of the wrist-joint are divided; leaving the connections of the tendons with the radius undisturbed. The *anterior* surface of the ulna is cleared, turning the knife towards the bone to avoid the artery and nerve, the articulation of the pisiform bone is opened—if not already done in making the incision—and the flexor tendons are separated from the carpus, the hand being depressed to relax them. To accomplish this, the process of the unciform bone must be clipped off with pliers, but the pisiform bone is left attached to the tendon of the flexor carpi ulnaris. In raising the tendons, the knife must not pass below the *bases* of the matacarpal bones, to avoid wounding the deep palmar arch. The *anterior ligament* of the wrist-joint is now divided. Then, introducing the pliers, the junction between the carpus and the metacarpus is severed, thus completely detaching the *whole carpus*, which is extracted *en masse* with sequestrum-forceps,—leaving the trapezium and pisiform bones. (Fig. 518.)

Fig. 518.*



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* Diagram showing upper and lower lines, and portions of bone included, for excision of the wrist.—A, deep palmar arch; B, trapezium; C, articular surface of head of ulna. (Lister.)

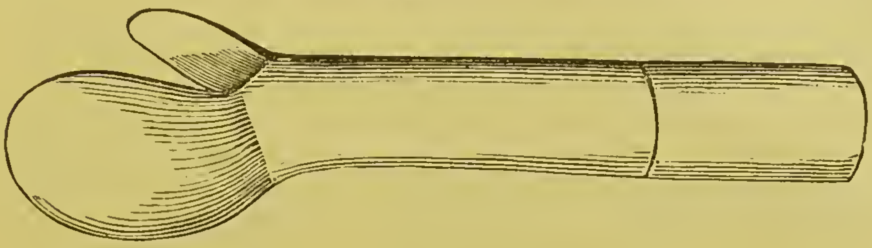
The ends of the *radius* and *ulna* are now made to protrude, from the ulnar incision, by everting the hand; and according to their state of caries on examination, the articular surfaces only, or a larger portion of the bones, should be excised. The head of the ulna may be sawn obliquely, removing the articular surface, but leaving the styloid process, and the ulna, therefore, of the same length as the radius; a provision for the subsequent symmetry and steadiness of the hand, as the angular interval between the bones becomes filled up by fresh ossific deposit. The end of the radius is then excised, by sawing off a thin slice, parallel to the general direction of the inferior articular surface. In doing this, the tendons in their grooves on the dorsal aspect of the bone need not be disturbed; it is sufficient to remove the bevelled ungrooved part of the bone-end, and thus the extensor secundi internodii pollicis may never come into view. This may seem a refinement; but the freedom with which the thumb and fingers can be extended, even within a day or two after the operation, when this point is attended to, shows its importance. The articular facet on the ulnar side of the radius is then clipped off with bone-nippers, applied longitudinally. In excising the ends of the ulna and radius successively, it is far better to take away too much bone than too little; a useful hand resulting in spite of very extensive excision. The *bases of the metacarpal bones* must then be examined and excised, saving as much bone as possible, but clipping off their articular surfaces transversely and laterally; even, when necessary, drilling the shaft into a hollow tube. The second and third bones are most easily reached from the radial incision, the fourth and fifth from the ulnar side. Next, the trapezium is seized with a strong pair of forceps and dissected out, carefully avoiding the tendon of the flexor carpi radialis, which lies firmly bound into the groove on the palmar aspect of this bone, and turning the knife close to the bone elsewhere to avoid wounding the radial artery. Having removed the trapezium, the base of the metacarpal bone of the thumb is pushed up and its articular surface clipped off; thus preventing the risk of recurrent disease, and reducing the thumb in length to the same extent as the fingers. Lastly, the pisiform bone should be examined, and its articular surface clipped off; the rest of the bone is left, if sound, as it retains the insertion of the flexor carpi ulnaris, and gives attachment to the anterior annular ligament; if unsound, the bone must be removed entirely.

In this operation, the extensors of the carpus are the only tendons necessarily divided; the flexor carpi radialis escapes, being connected with the second metacarpal bone *below* its base, and the flexor carpi ulnaris is left attached to the pisiform bone. All the flexors and extensors of the fingers, and all the extensors of the thumb, should be uninjured, and undisturbed beyond what is absolutely necessary for the operation of excision.

On removing the tourniquet, any hæmorrhage can be readily arrested by torsion or ligature. The radial incision is closed by sutures, and also the ulnar incision at its ends, leaving the middle portion open for the introduction of lint to allow free exit of the purulent discharge which necessarily follows.

The hand is placed on a suitable splint, extending up the forearm, and secured by a bandage. The most convenient form is an ordinary wooden splint, with an obtuse-angled piece of thick cork cemented to the palmar portion by means of fusod gutta-percha, and with a bar of cork stuck on transversely to the under surface of the splint so as to project at the side. Lister's splint, thus constructed (Fig. 519), possesses certain important advantages. The hand lies semiflexed, which is its natural position of repose; the fingers are midway between flexion and extension, into which it is necessary to bring them by daily passive movements; while a certain range of voluntary motion is also permitted, which the patient should be encouraged to exercise frequently during the day. Then again, this position is best adapted for allowing the extensors of the carpus to acquire fresh attachments; and, the palm resting on the sloping surface of cork, the splint cannot slip upwards; nor downwards, secured by turns of the bandage around the transverse bar of cork. This appendage to the splint specially keeps the *thumb* in position; it is thus allowed to fall below the level of the rest of the hand, so as to be most serviceable for opposition to the fingers; while the tendency to adduction of the thumb towards the index finger is prevented by a thick pad of lint placed in the angle between the two, under the turns of bandage around the transverse bar of cork. The palmar piece of cork should be hollowed out to receive the ball of the thumb.

Fig. 519.



After-treatment.—Two principles must be kept in view, in order to obtain a successful result. Firstly, to procure firm anchylosis of the wrist, by retaining it in a fixed position during the process of consolidation—for a period averaging six or seven weeks. Secondly, at the same time, to maintain the flexibility of the fingers and thumb daily; commencing flexion on the second day, whether inflammation has subsided or not. In executing these movements, each finger should be both flexed and extended to the full degree, while the connected metacarpal bone is held quite steady, so as not to disturb the wrist. Both these principles are provided for by the peculiar construction of the splint, and Professor Lister attaches more importance to their fulfilment, in the after-treatment, than to his method of operation.

Pronation and supination, also, must not long be neglected; and as the new wrist acquires firmness, flexion and extension, abduction and adduction should be occasionally encouraged. The period during which passive motion should be practised may be resolved into this rule; it must continue until the disposition to contract adhesions finally ceases—a few weeks or a few months.

When the patient leaves his bed, and carries his arm in a sling, the weight of the hand will make it gradually droop to the ulnar side; a tendency which is best counteracted by affixing two ledges of gutta-percha to the ulnar side of the splint—one to support the border of the hand, and the other to prevent any lateral shifting of the splint. As the hand acquires strength, more free play for the fingers should be allowed, by cutting away the splint up to the knuckles, leaving only the palm supported. Some support must be continued until the patient feels the wrist as strong without it as with it. Earlier disuse of this support would assuredly undo the work of previous management, and lead to an unsuccessful result. A year, or even two, of such finishing-off support may be required to gain the most useful hand.

Results.—Fifteen cases of Wrist-Excision are recorded by Mr. Lister, as from his own practice. Of these cases, twelve were successful; recovery taking place, and with a hand more or less completely useful in its varied movements of the fingers and thumb, and with combined strength and flexibility of the wrist. In one case the result was doubtful at the time of the report—four months after operation. In the remaining two cases, death ensued, though not directly from the operation; one patient dying, at the end of seven weeks, from advanced phthisis and other complaints; the other patient, after re-excision about six months subsequent to the original operation, lived yet two months longer, when death occurred from phlebitis and pyæmia. Secondary hæmorrhage, or any other bad symptom immediately referable to the operation, occurred in not a single instance.

Other and simple methods of operation have hitherto rarely proved successful; the results having been, in the majority of the few instances recorded, either a stiff and useless hand, or recurrence of the disease and secondary amputation.

Yet it may fairly be doubted whether the superior results attained by Lister's method have not been due—as he himself acknowledges—more to the principles on which the *after*-treatment was conducted, than to the plan and performance of the operation. This conclusion seems to be established by two significant facts in the history of Mr. Lister's cases—that the period of recovery and the resulting condition of the hand were about equal in his earlier and later cases, while the method of operation was different.

Professor Spence—by a method of excision apparently similar to Lister's—has operated in eight cases; two underwent secondary amputation of the forearm, but in none of the cases was the result fatal.

Author's Collection.

(1.) Royal Infirmary, Edinburgh; period, 1865–69. (Per Mr. P. H. Watson.) Number of cases, 12: recoveries, 9; deaths, 3.

(2.) Liverpool Royal Infirmary; period, five years, 1870. (Per Mr. W. J. Cleaver.) Number of cases, 6: recoveries, 6.

(3.) Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per. Mr. P. H. Watson.) Number of cases, 5: recoveries, 4; deaths, 1.

(4.) London Hospital; period, five years, 1870. (Per Mr. J. McCarthy.) Number of cases, 3: recoveries, 2; deaths, 1. Amputations after excision, 1: recoveries, 1.

(5.) King's College Hospital; period, five years, 1870. (Per the house surgeon.) Number of cases, 3: recoveries, 3.

(6.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 1: recoveries, 1.

(7.) St. Bartholomew's Hospital; period, 1866–70. (Per Mr. Callender.) Number of cases, 1: deaths, 1.

(8.) Royal Free Hospital; period, five years, 1870. Number of cases, 1: recoveries, 1.

(9.) Guy's Hospital; Westminster Hospital; Charing Cross Hospital; St. Mary's

Hospital; Great Northern Hospital; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; period, each five years, 1870. No cases.

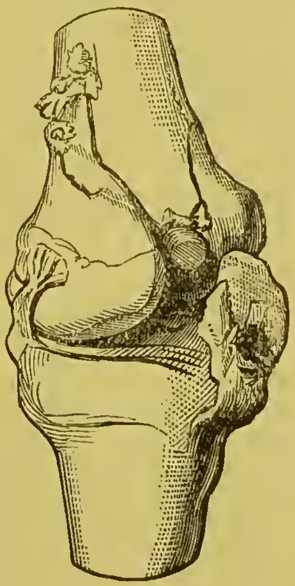
THE HAND may often be subjected very advantageously to various operations of Excision, both in regard to the *Metacarpal Bones*, and the *Phalangeal Bones* of the Fingers.

The *conditions* of Disease appropriate for Excision are precisely analogous with respect to any such operation on these bones of the hand, as in the corresponding bones of the foot. The articular ends, or the whole, of several or of single bones, of the metacarpus or of the fingers, may thus be removed; instead of having recourse to amputation of portions of the hand, which would unnecessarily include sound portions of this precious member. But the choice of either operation of removal, and the plan and performance of the procedure, must be determined by the kind and extent of disease, in each particular case. A very suggestive case of excision does much credit to Mr. Royes Bell, of King's College Hospital. He removed the proximal phalanx of the right thumb, with an enchromatous tumour which involved the whole of this bone. The incision was made along the dorsal aspect of the phalanx, but without dividing the tendons; and the result of this operation was so successful, that the girl could use her thumb in sewing and writing with perfect freedom. (See *Lancet*, 1872, vol. ii. p. 846.)

EXCISION OF THE JOINTS, FOR INJURY.

EXCISION OF THE KNEE-JOINT, FOR INJURY.—The operation of knee-joint excision, for injury to the joint, can only be suitable in certain conditions, intermediate between those which admit of cure without any operative interference, and those which should be subjected to amputation of the thigh. Such injuries are more frequently too extensive, both in regard to the joints and surrounding soft parts, to admit even of excision, and must be submitted to amputation,—which operation, therefore, for *injury*, is an alternative procedure. But the constitutional condition will very probably be far more favourable in extensive injury, than in extensive disease,—the former occurring often to persons in high health, and not when the constitutional reserve-power, necessary for the long process of reparation after excision, has been reduced by long-continued pain or exhausted by discharge and hectic fever. Hence, this primary consideration with reference to the operation, as for disease, may probably be altogether omitted in selecting excision rather than amputation for injury to the joint. The question of operation arises more commonly in Military than in Civil practice.

FIG. 520.*



Condition of Injury appropriate for Excision.—(1.) Lacerated wounds of the joint. Punctured wound may allow of closure, and the treatment for consequent synovitis. In the event of inflammatory disease, thus of traumatic origin, having terminated in destruction of the articular cartilages, without the supervention of anchylosis, the propriety of excision must be determined by the same consideration as with reference to idiopathic disease of the joint —namely, the measure of constitutional reserve-power. (2.) Compound fracture involving the joint. (3.) Compound dislocation of the joint. (4.) Gunshot wounds of the knee-joint may comprise one or more of these conditions, with perhaps, as a complication, the addition of a foreign body in, or near to, the joint. (Fig. 520.)

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* St. Thomas's Hosp. Mus., A. 126². Bones of a knee-joint. A conical ball has perforated the apex of the patella, producing a starred fracture. The ball is lodged between the condyles of the femur, which it has split apart. Some new bone has been formed in the shaft of the femur. Presented by W. MacCormac.

The *operation* is performed in accordance with the directions already given, when the joint is diseased; the incision being modified conformably to the state of the integument in injury of the joint.

The *after-treatment* also is the same, as to the retentive appliances, and their reapplication from time to time, only as occasion may absolutely render necessary; but the more severe inflammation apt to arise after excision for injury, must be promptly met by more actively repressive measures.

Results.—Cases of knee-joint excision for injury have been far less numerous than for disease; and insufficient to establish any general conclusions as to mortality or secondary amputation.

Cases of *lacerated* wound of the joint, for which the operation has been performed, may be noticed; one in the practice of Mr. Kempe, of Exeter, the patient aged thirty, and the result perfectly successful, at the end of a year the patient being enabled to load a railway van; and in another case excision was resorted to by the late Mr. Price, as a secondary operation,—the patient, six years old, having two months previously sustained an extensive laceration of the knee-joint by a cart-wheel, followed by profuse suppuration and burrowing sinus,—yet apparently the result was successful.

In a case of *punctured* wound of the knee-joint, by a needle, resulting in anchylosis with dislocation, at the end of one year and four months, Sir William Fergusson excised the joint; the patient recovering with a shortened but perfectly straight limb.

Cases of *compound fracture* of the knee-joint, for which excision was practised, have yielded some encouraging results. Dr. Watson performed the operation in a case of compound, comminuted fracture of the patella, with impaction of the fragments into the end of the femur; but death ensued. Mr. Crompton, however, in a case of compound fracture of the condyle of the femur, had a successful result to the operation; and, in a case of forcible separation of the lower epiphysis from the shaft of the femur, the patient being aged fifteen, sloughing and protrusion of the end of the femur took place, for which Mr. Canton excised the joint, and with a perfectly successful result. In a similar case, the same Surgeon having performed this operation, re-excision of a further protrusion of the femur was practised; and fibrous anchylosis with a useless limb resulting, Mr. Canton amputated the thigh, and the patient recovered.

Compound dislocation of the knee-joint will rarely admit of excision; owing to the extent of disorganization, amputation may be imperative.

Gunshot injury to the knee-joint has not unfrequently allowed of excision, but the results have been far more frequently successful in Civil than in Military practice. Successful cases have occurred: one at the London Hospital, under the care of Mr. J. Hutchinson; another, at the General Hospital, Birmingham, under Mr. Crompton; and M. Spillmann has collected the history of thirteen cases of knee-joint excision in Civil practice, for gunshot injury, with only three deaths. On the other hand, under, probably, the less favourable circumstances of Military practice, the operation has been deadly. Of twenty-one such cases, collected by M. Spillmann, nineteen were fatal. During the Crimean War, the returns of excision show only one case of excision of the knee-joint, and with a fatal issue. In the American War, the report from the Surgeon-General's department presents in a tabulated form 770 terminated cases of gunshot wounds of the knee-joint; in eleven cases of excision, only two recovered, or a mortality of 90 per cent.; whilst the mortality from amputation was far lower,—73·43 per cent., though still a very melancholy record. Free incisions into the joint seem to have succeeded little better than excision. The results of the operation, as collected by M. Pénière, are very impressive. In Civil practice, of seven cases, there were four recoveries and three deaths, or 1 in $2\frac{1}{3}$; whereas, in Military practice, of twenty cases, three only recovered and seventeen died,—an overwhelming mortality. All these cases are taken almost exclusively from foreign sources. It would appear, therefore, that while excision of the knee-joint for injury may be less successful than the average *minimum* success of the operation for disease, the mortality in Military practice is so excessive, as to suggest the propriety of there abandoning the operation in favour of amputation of the thigh.

Author's Collection.

(1.) Great Northern Hospital; period, five years, 1870. (Per Mr. J. Willis.) Number of cases, 2: recoveries, 2.

(2.) St. Thomas's Hospital; period, 1866–70. (Per Mr. F. Churchill.) Number of cases, 1: deaths, 1.

(3.) Royal Free Hospital; period, five years, 1870. Number of cases, 1: recoveries, 1.

(4.) Royal Infirmary, Edinburgh; period, five years, 1870. (Per Mr. P. H. Watson.) Number of cases, 1: deaths, 1.

(5.) Chalmers' Hospital, Edinburgh; period, six years, 1870. (Per Mr. P. H. Watson.) Number of cases, 1: deaths, 1.

(6.) Guy's Hospital; St. Bartholomew's Hospital; London Hospital; Westminster Hospital; St. Mary's Hospital; Charing Cross Hospital; King's College Hospital; Liverpool Royal Infirmary; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; period, each five years, 1870. No cases.

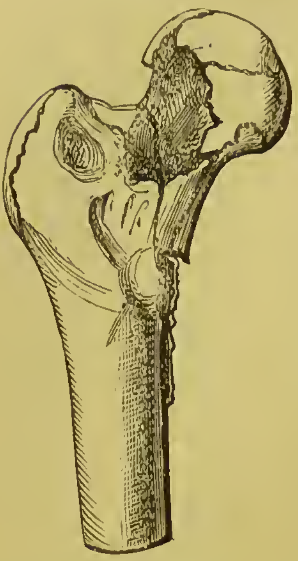
EXCISION OF THE HIP-JOINT, FOR INJURY.—This operation, like that for the knee-joint on account of injury, relates more to Military than to Civil practice. It was first performed, as reported by Oppenheim, at the battle of Eski-Arna-Utlar, between the Russians and Turks, on the 5th of May, 1829. The injury was that of a gunshot wound of the hip, with fracture of the head and neck of the femur and of the upper edge of the cotyloid cavity; the soft parts being little injured, and the nerves and large vessels untouched. Death took place after the seventeenth day, apparently, however, from fright. The operation was advocated by Guthrie; and practised during the Crimean War, both in the English and French Hospitals.

Conditions of Injury appropriate for Excision.—(1.) Compound Fracture of the upper part of the femur, and perhaps involving the acetabulum.

(2.) Compound dislocation of the hip-joint—a rare form of injury.

(3.) Gunshot wound of the hip-joint; comprising either of these conditions, and more often fracture. (Fig. 521.) The diagnosis, as to the kind and extent of injury, may be very difficult. Possibly, no shortening, eversion, or crepitus, and little loss of power to move the limb in flexion or extension; only a small aperture to be seen in the thigh, before or behind, with no hæmorrhage, and no pain experienced by the patient.

FIG. 521.*



The *operation* of excision for injury is performed in the same way as for disease, modified only by the state of the integument. *After-treatment* also requires no special notice.

Results.—In the Crimea, of the fourteen cases of this operation in the English Hospitals, only one recovered; of the thirteen cases in the French Hospitals, all were fatal; and in the Schleswig-Holstein campaign, of the seven cases, there was only one recovery.

The successful Crimean case had been operated on by Dr. O'Leary. A fragment of shell struck the great trochanter of the left femur, producing a fracture, which commenced close to the head of the bone, and extended downwards and forwards between the two trochanters, terminating about an inch and a quarter below the lesser. The external wound was small. The head of the femur and the trochanters were removed. In three months the man left his bed on crutches. At the end of six months, he had gradually regained the use of his limb, and, some time afterwards, was seen in London in excellent health.

Although an almost invariably fatal operation, the duration of life after excision shows that it has no immediate danger. In the cases recorded, one of the patients lived five weeks, others from six to seventeen days, and only one for so short a period as twenty-two hours.

On the other hand, natural recovery is almost hopeless. From gunshot wound of the hip-joint, one such result occurred after the battle of Solferino; and another was seen at Nantes, in 1830, by M. Boinet.

Compared with Amputation at the Hip-joint: in Military practice, recovery very rarely occurs, death taking place usually within a day or two after this operation.

In the dilemma from the almost certain mortality of trusting to Nature, or performing amputation, the Surgeon may perhaps judiciously have recourse to the chance afforded by excision.

In the fifteen Hospitals stated in previous tables, respecting Joint-Excisions during the five years, 1870, it appears, from the returns with which I have been favoured, that there has been no case of excision of the Hip-joint, for Injury.

EXCISION OF THE ANKLE-JOINT, FOR INJURY.—This operation is referred to by Faure, as having been performed in a case which occurred at the battle of Fontenoy; a wound of the ankle-joint by a "biscaïen." The articular ends of the tibia and fibula, with the astragalus and portions of the other tarsal bones, were excised; but amputation was performed on the forty-seventh day. Subsequently, excision of the articular ends of bone was performed by Mr. Cooper, of Bungay, for compound dislocation; the case being referred to, in 1758, by Mr. Benjamin Gooch, of Norwich. Cases in which, to the extent of two, three, and even four inches, the ends of the tibia and fibula were removed for injury, are related by Bilguer in 1781. Moreau, in 1792, performed this operation, with success, for compound dislocation, nineteen days after the accident. In 1805, Park alludes to a case of excision of the tibial end for similar injury to the ankle; and, according to Mr. Hey, of Leeds, in the same year, Mr. Taylor, of Wakefield, had performed this operation in five cases. Sir Astley Cooper, Liston, and Malgaigne have advocated removal of the ends of the tibia and fibula, in cases of compound dislocation, as being preferable to reduction or amputation. Mr. Jones, of Jersey, performed complete excision—removing the articular ends of bone and the surface of the astragalus, as a secondary operation, twenty-two days after compound dislocation with fracture of the malleoli, followed by necrosis, profuse suppuration, and constitutional disturbance. In about three months, the patient, having for ten days previously been able to walk some distance without support, ran away from the Hospital, and walked a distance of five miles with the aid of a stick and a crutch. A similar operation for a similar condition of the parts was performed, five months after the injury, by C. W. Klose, in 1854. The patient, sixty years of age, at the end of ten weeks was able to walk out with a crutch.

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* Univ. Coll. Mus., 91.

Conditions of Injury appropriate for Excision.—(1.) Compound fracture of the malleoli, with perhaps contusion of the bone.

(2.) Compound dislocation of the ankle-joint.

In either of these conditions, it is presumed that the ends of bone cannot be reduced, or if reduced, kept in position; and that the integuments are not so much lacerated or contused as to slough; unaccompanied also with comminution of the other tarsal bones.

The *operation*, and *after*-treatment, require no special notice.

Results.—In twenty-nine cases, reported in Jaeger's tables, only one death occurred. Malgaigne records the unexceptional success of five operations by Taylor, six by Josse, and nine by Sir A. Cooper.

Compared with Amputation of the Leg, for Injury, the balance is highly favourable to excision. At Guy's Hospital, the mortality has been 62·5 per cent. in primary, and 66·66 per cent. in secondary amputations; while in the Royal Infirmary of Edinburgh, Mr. Syme records a mortality of eleven, or 65 per cent., out of thirteen amputations for compound dislocation of the tibia and fibula.

As to the *State of the Foot*, after excision, the resulting condition has usually been anchylosis; but in some cases, reported by Sir A. Cooper, motion was preserved.

Author's Collection.

(1.) London Hospital, 1870. Number of cases, 2: recoveries, 2; secondary amputations, 1; deaths, 1.

(2.) Royal Infirmary, Edinburgh, 1870. Number of cases, 2: recoveries, 1; deaths, 1.

(3.) Liverpool Royal Infirmary, 1870. Number of cases, 2: recoveries, 2: secondary amputations, 1; recoveries, 1.

(4.) Guy's Hospital; St. Bartholomew's Hospital; St. Thomas's Hospital; King's College Hospital; Charing Cross Hospital; St. Mary's Hospital; Westminster Hospital; Royal Free Hospital; Great Northern Hospital; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; Chalmers' Hospital, Edinburgh; period, 1870. No cases.

In each of these Hospitals, the period is that of five years; and the returns were made to me by those Surgeons whose names are severally affixed in the previous tables.

Excision of the Shoulder-joint, for Injury.—The contingencies of warfare render this operation far more common in Military than in Civil practice. It would appear from the French official report in the Crimea, that in open engagements the superior extremity was wounded once in every 4·3, and in siege operations once in every 6·2, of all wounds reported. Of forty-seven gunshot wounds of the upper extremity, twenty-eight were of the shoulder and arm. The advanced position of the soldier's shoulder, in the act of firing, exposes that part more particularly to bullet-wounds; while it also shares the liability of other parts to grape-shot, fragments of shell, and cannon-balls.

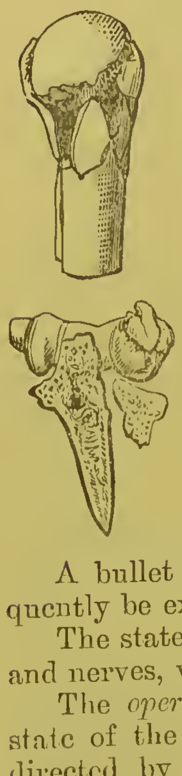
M. Boucher, of Lille, seems to have first performed the operation of shoulder-joint excision, after the battle of Fontenoy, in May, 1745. Subsequently complete excisions were practised successfully by Percy, Sabatier, Larrey, Lauer, Ingalls of Boston, Mann, Guthrie, Baudens, Hancock, and other Surgeons.

Conditions of Injury appropriate for Excision.—(1.) Compound and comminuted fracture of the head and neck of the humerus.

(2.) Compound dislocation.

(3.) Gunshot wound, involving the head or neck of the humerus; extending down the shaft even into the medullary canal. Such fissures may be left, and recovery ensue; or, the shaft to the extent of four or five inches has been removed, with the head, and a successful result obtained. (Fig. 522.)

Fig. 522.*



Complications, by fracture of the glenoid cavity of the scapula, through the neck, or extending into the body, or involving the coracoid and acromion processes, may require the removal of such additional fragments, or they may be left to exfoliate; the result proving successful, although recovery be protracted. Thus, Larrey's case was remarkable for the extent of bone excised,—head of the humerus, acromion, and proximate end of the clavicle; yet the patient recovered, and with considerable use of the arm.

Partial excision of the head of the humerus was practised in the Crimea. The after-mobility was more restricted than as the result of complete excision.

A bullet imbedded in the head of the humerus may not unfrequently be extracted, without excision.

The state of the integuments, and of injury to the axillary vessels and nerves, will regulate the propriety of excision.

The *operation* is performed as for disease, modified only by the state of the integuments. The shape of the incision will be chiefly directed by the situation of the wound or wounds in the skin. A shattered shoulder from gunshot wound necessitates a sort of trimming-up excision; by enlarging the wound, and extracting splinters of bone. A perpendicular linear incision, from the acromion process downwards through the middle of the deltoid muscle, will probably suffice to expose the crushed head of the humerus. Removal of the disintegrated and splinted fragments must then be performed *secundum artem.*

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* St. Thomas's Hosp. Mus., A. 67^1. (W. MacCormac.)

After-treatment must be conducted on the same principle.

Results.—In 53 primary excisions of the shoulder-joint for injury, the mortality was 16. In 34 secondary operations, there were 6 deaths. Combining these two series of cases, and adding thereto 6 operations, with 3 deaths, by Baudens, and 3 others successful—1 by Langenbeck, and 2 by Textor, of which it is unknown whether they were primary or secondary—the total number is 96 cases, with 25 deaths, or a mortality of 26 per cent.

Secondary excision has a comparatively more favourable mortality than the primary operation. Thus, in the 53 primary excisions, the percentage was 30·18; whereas, in the 34 secondary operations, the percentage was only 17·64,—a balance of 12·54 in favour of the latter. More striking are the results reported by Esmarch. Of 6 excisions of the head of the humerus, performed within twenty-four hours after the injury, 2 died; of 3 during the inflammatory stage, or on the third or fourth day, 2 died; whereas of 10 after suppuration was established, only the same proportion, 2, died. Of 26 patients in the ambulances of M. Baudens, 11 immediate excisions made 10 recoveries, 3 were submitted to secondary excision, and all were successful. In the Crimean returns, also, the cases were equally successful.

The *period of recovery* after shoulder-joint excision, for injury, seems to be about two or three months in respect to treatment, the complete result as to the usefulness of the arm not being obtained under twelve months, or a longer period. In the Crimea, the Schleswig-Holstein campaign, and the last Indian mutiny, many of the soldiers who had been thus operated on, returned to their regiments or to a modified duty before the end of the war.

Compared with Natural Cure, excision has proved most favourable. Thus, of 8 cases suited for excision, but which were left to nature, 5 died, and the remaining 3, at the end of six months, were uncured. Of M. Baudens' cases, 15 were left to nature; 8 of these died from purulent infection, and 4 suffered long from fistulous openings—the remaining 3 having undergone secondary excision.

Compared with Amputation at the Shoulder-joint, the results of excision are also favourable. In the Crimea, of 60 such amputations, 19 were fatal, or a percentage of 31·6; leaving in favour of excision, a balance of 5·6 per cent.

A curious comparison has been drawn between the results of excision on the right and left shoulder-joints, in relation to the mortality of operation. According to Esmarch, operation on the right side is more successful than on the left side; of the latter cases, 6 out of 12 having died, but only 1 out of 7 of right-shoulder excisions.

Author's Collection.

(1.) Royal Infirmary, Edinburgh, 1870. Number of cases, 1: recoveries, 1.
(2.) Royal Infirmary, Liverpool, 1870. Number of cases, 1: recoveries, 1.

(3.) St. Bartholomew's Hospital; St. Thomas's Hospital; Guy's Hospital; St. Mary's Hospital; King's College Hospital; London Hospital; Westminster Hospital; Charing Cross Hospital; Royal Free Hospital; Great Northern Hospital; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; Chalmers' Hospital, Edinburgh; period, 1870. No cases.

In each of these Hospitals, the period is that of five years; and the returns were made to me by those Surgeons whose names are severally affixed in the previous tables.

Excision of the Elbow-joint, for Injury.—This operation appears to have been first performed by Wainman, of Shripton, in 1758 or 1759; the case having been one of compound dislocation, the articular end of the humerus was removed just above the olecranon fossa. The patient recovered, and with a flexible arm, "as if nothing had ever been amiss." This operation is famous in the history of Excisional Surgery of the Joints, on account of its very early date. Subsequently, Tyre, of Gloucester, removed two inches and a half of the lower end of the humerus, for a compound dislocation. Larrey urged this excision upon his Surgeons, but, according to Percy, without much effect; "timidity, carelessness, routine, and indifference (words to be remembered) too often led them to prefer amputation, even under the very eyes of the old chieftain of Military Surgery." In 1840, Mr. Alcock could find no instance of the *complete* excision of the elbow-joint, in the annals of either British or French Military Surgery. It was not until the Schleswig-Holstein War of 1848-51, that this operation was really introduced into Military practice, by B. Langenbeck, of Berlin, and L. Stromeyer, of Erlangen. Excision of the elbow-joint for injury is, indeed, more often required in warfare than in Civil practice; though the nature of the injuries, and the circumstances of the patient after operation, may, as with regard to other joints, render the prospect of recovery less favourable in the one case than in the other.

Conditions of Injury appropriate for Excision.—(1.) Compound and comminuted fracture of the elbow-joint. (2.) Compound dislocation. (3.) Gunshot wound, involving the joint.

Fissures of the humerus, just above the joint, more commonly extend downward than upward. The track of a ball near the joint often induces caries, which would ultimately require excision.

But the state of the integument, and of the brachial artery and the nerves, at the bend of the elbow, will regulate the propriety of this operation instead of amputation.

The *operation*, and *after*-treatment, are analogous to that for disease.

Results.—In twelve cases of severe injury to the elbow-joint, reported by Mr. Jonathan Hutchinson, the results were decidedly in favour of excision, rather than of either natural cure or primary amputation. An elbow-joint apparently preserved by the reduction of compound fracture or dislocation, is apt to entail profuse suppuration and constitutional disturbance, perhaps necessitating amputation of the arm; or the motion and consequent use of the arm eventually is less than after removal of the ends of bone. Both these conclusions are established by Mr. Hutchinson's cases; and the latter, as to the use of the arm, is confirmed by Macleod's report of the Surgery in the Crimean War.

In *Civil* Hospitals, the success of operation is very remarkable; of twenty-one cases, authenticated by Dr. R. Hodges, in his excellent treatise on Joint-Excisions, a rapid recovery ensued in all but one, the fatal result of which was in no way attributable to the operation.

Compared with Amputation, the mortality of excision contrasts very favourably. Of 13 amputations of the upper extremity, in Guy's Hospital, on account of injury, 1 in 4·33, or 33 per cent., of primary, and 1 in 5, or 20 per cent., of secondary operations, proved fatal.

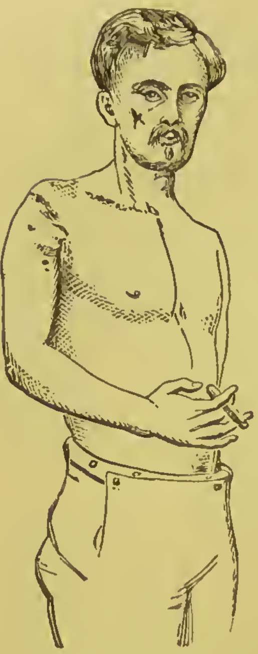
In *Military* Hospitals, the results have been less successful, but still in favour of excision. Combining the experience of the Crimean War, and of the Schleswig-Holstein campaign, we have a total number of cases in proof of this position. Of 60 excisions, 11 were fatal, or a mortality of 18·33 per cent. Whereas, of 208 *amputations*, 48 were fatal, or a mortality of 23·07 per cent. Thence, a percentage of 4·74 in favour of excision. *Partial* excisions have not been so successful as the complete operation. This was shown in *Civil* practice, by the results of 7 of the 21 cases referred to, where the partial operation was performed; 3 made good results, 1 ended in partial anchylosis, in 1 extension was imperfect, in 1 failure was imputed to habits of intemperance, and of 1 the result is wanting. *Military* practice, as taught by the results of the Crimean War, points to the same conclusions. Partial excisions of the elbow were more tedious in recovery, more liable to fail, and the results, when successful, were less perfect.

Secondary excision, at the period of suppuration, say at the end of a week, if it be not preferable to the primary operation, would seem not to be unfavourable to recovery. This is the opinion of Stromeyer, and it is confirmed by Esmarch's statistics—that of 11 excisions within the first twenty-four hours of the injury, 1 died; of 20 performed during the inflammatory stage—from the second to the fourth day, 4 died; of 9 secondary excisions in the period from the eighth to the thirty-seventh day, only 1 died.

The *right* elbow-joint, like the right shoulder, would appear to be more favourable for excision, in regard to recovery. On the right side, only 2 in 20 operations proved fatal; whereas, on the left side, 4 in 19 were fatal—a more than double mortality. Indeed, comparing the total results of the shoulder and elbow joint excisions, the mortality on the left arm to that on the right is as 3 to 1.

In a notable case, Mr. MacCormac performed a *double* excision; one of the right shoulder-joint, and the other of the right elbow-joint; in consequence of gunshot fracture of the upper end of the humerus, and also of the external condyle of the humerus, with extensive fracture of the ulna in its upper third, including the olecranon, and implicating the head of the radius. The patient, Louis St. Aubin, belonged to a French *corps d'élite*, the 3rd Chasseurs d'Afrique. He was wounded at the battle of Sedan. Having had his horse shot under him in a cavalry charge, while struggling on foot, he received a severe bayonet thrust in the face; but, later in the day, having engaged the enemy again, he was completely disabled by a shell-explosion, which severely lacerated the bones and soft parts of his right arm, in the region of the shoulder and the elbow joints. This splendid soldier bore excision of the shoulder-joint without the influence of chloroform, which he resolutely refused; the original wound was utilized by extending it upward and downward, and then four inches of the upper articular end of the humerus was removed, at the limit of the fractured portion. Under chloroform, the elbow-joint was next submitted to operation, the integumental wound being enlarged so as to allow of sub-periosteal excision of the ulnar fragments at the junction of the upper and middle thirds of that bone; only a thin slice of the humerus was removed, and the articular head of the radius. Thus, in this joint, the tubercle of the radius was left with its muscular attachments, and the periosteum of the ulnar portion of bone excised, whereby its regeneration might take place. After some suppuration, and apparently pyæmic infection, from which he rallied, the elbow-wound healed, and the shoulder also, except a sinus leading to a necrosed piece of bone. The annexed figure, from a photograph (Fig. 523), shows the result. The elbow-joint was re-formed by the reproduction of bone so as to leave scarcely any deformity. He can flex and extend the elbow; pronate and supinate the forearm. The hand also is regaining its power. In the shoulder, the motions backward and forward are freely executed by the pectoralis and latissimus dorsi muscles; although the power of raising the arm from the side is limited, owing chiefly to the destruction of the greater portion of the deltoid muscle. This case, therefore, presents a probably *unique* illustration of a successful result, after excision for gunshot injury of the elbow and shoulder joints of the same arm; and the double operation having been performed at the same time. ("Med.-Chir. Trans.," vol. lv.)

FIG. 523.



Author's Collection.

(1.) Royal Infirmary, Liverpool, 1870. Number of cases, 8: recoveries, 8.

(2.) London Hospital, 1870. Number of cases, 6: recoveries, 5; deaths, 1.

(3.) Royal Free Hospital. Number of cases, 2: recoveries, 2.

(4.) Royal Infirmary, Edinburgh, 1870. Number of cases, 2: recoveries, 2; secondary amputations, 1; deaths, 1.

(5.) Great Northern Hospital, 1870. Number of cases, 1: recoveries, 1.

(6.) St. Thomas's Hospital; Guy's Hospital; St. Bartholomew's Hospital; Westminster Hospital; St. Mary's Hospital; Charing Cross Hospital; King's College Hospital; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; Chalmers' Hospital, Edinburgh.

In each of these Hospitals, the period is that of five years, 1870; and the returns were made to me by those Surgeons whose names are severally affixed in the previous tables.

EXCISION OF THE WRIST, FOR INJURY.—A partial excision of the wrist-*joint*—the radio-carpal articulation—appears to have been first performed, for injury, by Cooper, of Bungay. "He sawed off the head of the radius, which passed through and made a dismal laceration of the tendons at the wrist, and the patient found little or no defect in the strength or motion of the joint." Thus reported by Benjamin Gooch, in 1758, this operation was practised also by that Surgeon, who succeeded beyond his expectation in cases of a similar nature. At about the same period, M. Bagieu removed the comminuted bones of the wrist-joint, crushed by gunshot injury; anchylosis ensued, and the fingers were left so flexible, that the patient, a soldier, aged twenty-five, was able to write and draw, and retained to a very considerable extent the shape of the hand. About the year 1773, Bilguer excised some two or three inches of the wrist-end of the ulna, in a case of injury. In 1800, M. St. Hilaire, of Montpellier, removed the ends of both radius and ulna, for compound dislocation, and with perfect success. In 1828, M. Hublier, of Provins, performed the some operation, for similar injury accompanied with rupture of the tendons; and Huguier and Rossi repeated it for gunshot wounds of the wrist. Subsequently, excision was performed in the Crimea.

Conditions of Injury appropriate for Excision.—The comparatively few cases recorded, with regard to excision for injury, are insufficient to establish any general conclusions. But, so far as experience has extended, and the analogy suggested by other joints, the following forms of injury to the wrist would seem to be proper for some such operation:—

(1.) Compound and comminuted fracture.
(2.) Compound dislocation.
(3.) Gunshot wound, comprising either or both these conditions.

The complication of injury to the tendons at the wrist does not forbid the operation; but the state of the adjacent vessels and nerves may be more important. Preservation of the hand, even in the most imperfect result for use, is so great a gain over the entire loss of this member, that the chance offered by excision will generally be preferable to primary amputation, at the wrist or in the forearm.

The *operation* and *after*-treatment must be conducted on the principles laid down as for disease, modified only by the circumstances of the injury.

Results.—Some of the earlier cases have already been noticed. In the Crimea three cases of wrist-injury were submitted to excision, with one fatal result.

Partial excision, for compound dislocation of one or more of the carpal bones, has been practised occasionally, and with some success. Thus, Sir A. Cooper removed the scaphoid, and Malgaigne the semilunar bone.

Author's Collection.

(1.) London Hospital, 1870. Number of cases, 1: recoveries, 1; secondary amputations, 1; recoveries, 1.

(2.) Royal Infirmary, Edinburgh, 1870. Number of cases, 1: deaths, 1.

(3.) St. Thomas's Hospital; Guy's Hospital; St. Bartholomew's Hospital; King's College Hospital; St. Mary's Hospital; Westminster Hospital; Charing Cross Hospital; Royal Free Hospital; Great Northern Hospital; Liverpool Royal Infirmary; Royal Albert Hospital, Devonport; Royal Sea-Bathing Infirmary, Margate; Chalmers' Hospital, Edinburgh. No cases.

In each of these Hospitals, the period is that of five years, 1870; and the returns were made to me by those Surgeons whose names are severally affixed in the previous tables.

Excision of Bones.

Excision of Upper Jaw and Lower Jaw.—See Diseases of the Jaws.

Excision of the Scapula.—Complete Excision of this bone was originally performed by Cumming, in 1808; afterwards by Gaetani Bey, 1830; and by Larrey, 1838; each of whom amputated the arm, and then excised the scapula; and more recently by Syme, Jones of Jersey, Cock, Fergusson, Pollock, and MacCormac, all of whom disarticulated at the shoulder-joint, leaving the arm untouched. The scapula, with the clavicle, have been removed by American Surgeons;

by Massey, 1837; by McClellan, 1838; and both these bones—or rather the outer half of the clavicle—together with the upper extremity, have been removed by Gilbert, in two cases; and by Massey, 1845. Partial excision of the scapula has been practised by Liston, 1819; Luke, 1828; and by Hayman, Janson, Wützer, Textor, Gross, and the author. In these operations, the glenoid cavity was always left—the only portion in Gross's case.

The *conditions of disease* for which excision of the scapula may be required, in whole or in part, are caries or necrosis, and tumour.

The *results* of operation have been successful in the majority of cases, unless from the recurrence of the disease, and the arm has become very useful. Even the formidable operations of excision including the clavicle, and with amputation of the upper extremity, have proved successful.

Operation.—Partial excision of the scapula, for caries or a tumour, will require an incision, varying in shape and extent, according to the portion of bone, or the size and relative position of the tumour, to be removed. The *body* of the scapula may be excised by a T-shaped incision, so placed as to correspond to the spine and middle of the body of the bone. The flaps having been well reflected, and the bone or tumour thoroughly exposed, the saw is applied below the spine and the neck of the bone, which is then dissected out of its bed. Hæmorrhage may be inconsiderable, unless the subscapular or the dorsal artery be divided. The *spine* of the scapula can be readily exposed by an incision along its projecting border from the acromion, or to include this process if necessary. The bone is removed by a small saw or cutting-pliers, care being taken to avoid the joint, if the acromion be removed. Hæmorrhage will probably be inconsiderable, no vessel of any consequence having been severed. I have thus removed this portion of the scapula with little difficulty. The *supra-spinous* portion of the bone might be reached by a similar procedure.

Complete excision of the scapula may be accomplished by a similar operation to that for the removal of the body of the bone; a T-shaped incision, but extending from the acromial end of the clavicle to the posterior border, and vertically downwards to the inferior angle, of the scapula. The flaps, thus marked out, are to be well reflected; then, the acromio-clavicular articulation must be divided, or the adjoining portion of the clavicle or the base of the acromion may be sawn through, the muscles attached to the coracoid process must be divided, and the shoulder-joint opened, carefully avoiding the axillary artery and plexus of nerves on its inner aspect; lastly, the muscles attached to the superior and posterior borders of the bone are divided, with the supra-scapular and dorsal arteries, and the bone is raised from behind forwards to the axilla, there dividing the subscapular artery in completing the severation of the axillary attachments. Or, the bone may be raised from the axilla backwards, dividing the subscapular artery in the first instance; a less convenient method of procedure, owing to the copious hæmorrhage. The vessels must be secured by ligature or torsion; and the amount of hæmorrhage will be perilous, in proportion to the vascular character of the tumour. The flaps of integument are replaced and retained by points of suture.

The appearances before, and after, this operation, are here shown in a case by Mr. W. MacCormac. (Figs. 524, 525.) In this case the

FIG. 524.*

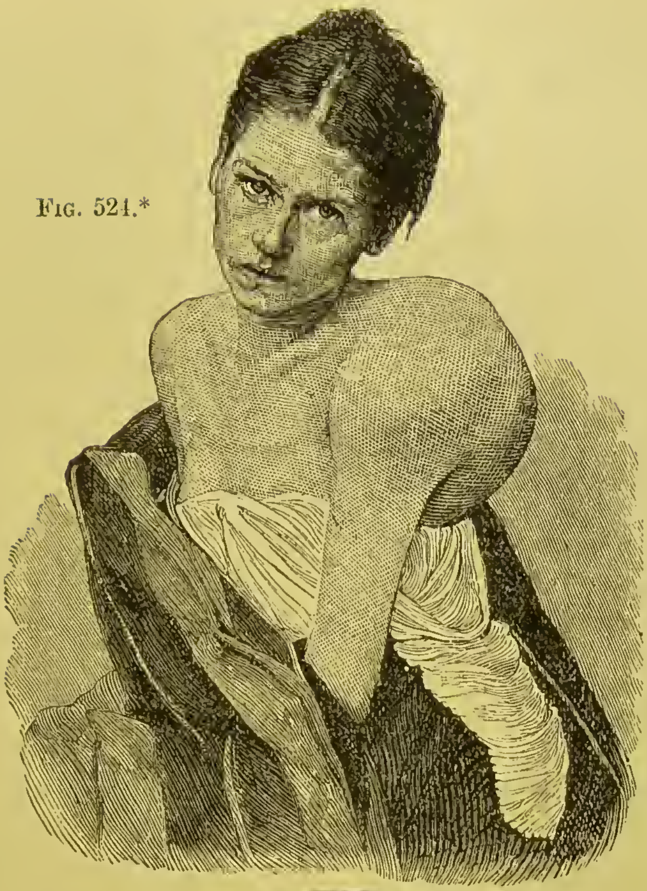
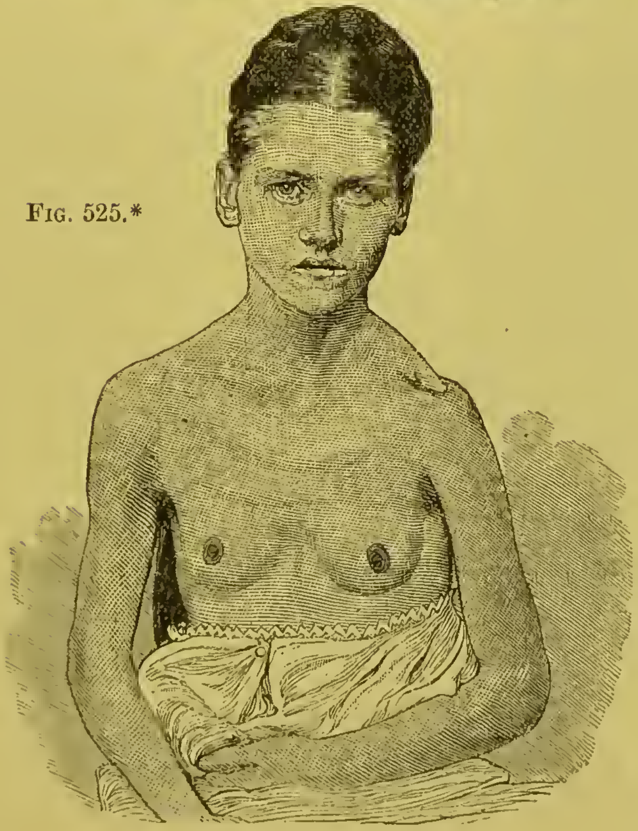


FIG. 525.*



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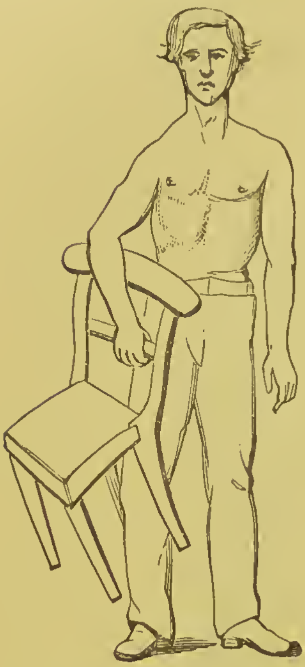
* St. Thomas's Hosp. Reports, 1876.

tumour—a myxoma—had been growing slowly for seven years, from the date when the patient first discovered it, below the spine of the scapula, and about the size of a walnut. Within four months of operation, it had attained only to the bulk of a large orange; then it increased rapidly to as big as a boy's head. The patient made a good recovery from the operation, but after six months she died from secondary growths in both lungs.

FIG. 526.



The usefulness of the arm is well exhibited by the result of a complete excision of the scapula, by Mr. Syme. (Fig. 526.)

Excision of the scapula, with previous excision of the *head of the humerus*, was performed by Dr. S. Logan; the disease in both bones having been caries, consequent on injury by a severe blow. An excellent result followed in three months; the wound had healed, and the cavity left by operation was completely occupied with a firm mass of deposit, while the limb had acquired the following uses, in regard to strength and power of movement:—the patient could lift perpendicularly twenty-six pounds, horizontally twenty-six and a half pounds, and by simply flexing the forearm he could raise fourteen pounds, could place his hand on either ear or shoulder, and could pass the hand freely over the face and front of the trunk, but could not execute similar movements backwards.

EXCISION OF SCAPULA, WITH AMPUTATION OF THE ARM AT SHOULDER-JOINT.—This formidable operation was originally performed, as already stated, by Cumming, 1808; afterwards by Gaetani Bey, 1830, and by Larrey, 1838; all of whom operated for gunshot injury—involving the arm, shoulder-joint, and scapula. A similar operation, for injury from machinery, is recorded by Mr. Patrick Heron Watson in the "Edin. Med. Journ.," 1869.* But this double operation—excision and amputation—has also been performed *separately*, an interval of time elapsing between the former and the latter. Thus, Rigaud, of Strasburg, removed the scapula and also the outer extremity of the clavicle, eight months after amputation at the shoulder-joint. In two months the wound healed, and two years afterwards the patient still remained well. A similar operation was performed by Sir. W. Fergusson in 1847, for caries of the scapula; amputation of the arm at the shoulder having been performed three years previously, for similar disease. The patient was still alive and well in 1870, twenty-three years after operation.

EXCISION OF THE CLAVICLE.—*Partial* excision of this bone, for necrosis, may be accomplished by an incision along the affected portion of bone, which, lying subcutaneously, can be removed with tolerable facility. The sternal end of the clavicle has been excised on account of its pressing on the œsophagus, in a case of permanent dislocation backwards.

Complete excision of the clavicle, for an osseous tumour, may be undertaken in like manner, by an incision extending along the bone from end to end; but owing to the subjacent parts, the removal of the entire bone is a proportionately more formidable operation.

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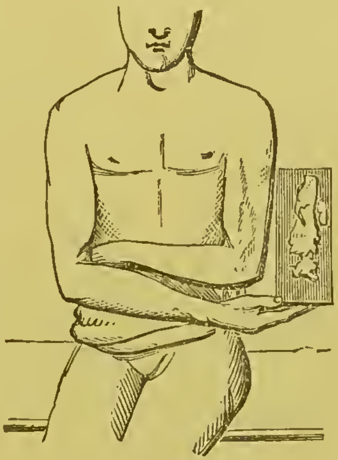
* See also cases collected by C. S. Jeaffreson, of Newcastle, *Lancet*, 1874.

This bone has been wholly or partially excised by Mott, of New York, 1828; Warren; Travers; Davie, of Bungay; Curtis, of Chicago; Cooper of San Francisco, and Syme.

EXCISION OF THE RADIUS OR ULNA.—The bones of the forearm have early been subjected to excision, *partially* or *completely*. Thus, Dr. Butts, of Virginia, has removed the whole *radius*. The result was a useful arm. Carnochan, of New York, and the late Mr. Jones, of Jersey, excised the whole *ulna*, successfully. Sir William Fergusson has also performed these excisional operations, and with entirely successful results, in the preservation of a useful arm.

EXCISION OF THE HUMERUS.—A considerable portion of this bone has been removed, with a successful result; and a more remarkable feature was presented in one case—a regeneration of the shaft of the bone to a considerable extent. (Fig. 527.) This case, by Mr. Wilkes, is fully reported in the "Trans. Path. Soc.," vol. xxi. As showing the further tendency to operations of this kind, I may mention a case in which the lower half of the ulna was excised for myeloid tumour, by Mr. Clement Lucas, the result being a useful limb;[*] in another case, the carpal ends of both radius and ulna were removed, for apparently osteo-aneurism, by Mr. Hancock, the hand remaining useful; and a similar operation of excision by Mr. Henry Morris, in the case of a myeloid tumour, also resulted in a useful hand.[†] Cases such as these were among those originally selected, by Sir W. Fergusson, in illustration of Conservative Surgery[‡]—the preservation of the integrity of the body as far as possible, in the removal of parts. But as exhibiting the guidance of the conditions of *disease*, or injury, in the design and performance of operations, *e.g.*, on the joints and bones, the term Pathological Operative Surgery, which some years since I suggested,[§] would seem to be more appropriate than that of Conservative,—which merely expresses the obviously implied object of all Surgery. The *guiding* principle referred to is far more important and significant; for Surgery must, necessarily, be conservative or preservative,—or, it is nothing.

FIG. 527.



EXCISION OF THE TIBIA OR FIBULA.—*Partial* excision of either of these bones, in consequence of disease or injury, can be accomplished without much difficulty by simple incisions, varying according to the circumstances of the case. In the case here represented (Fig. 528), I removed a considerable extent of the shaft of the fibula.

Complete removal of the fibula was readily and successfully performed by Erichsen, for necrosis, in a child of six years of age; the line of incision corresponding to the whole length of the bone. After such operation, an inner splint must be applied to obviate the tendency to varus which will ensue.

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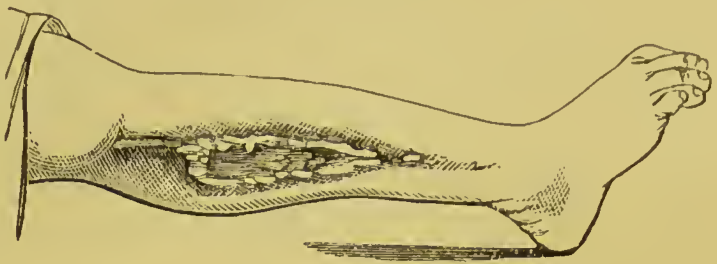
[*] "Trans. Clin. Soc.," 1877.

[†] Ibid., 1877.

[‡] *Medical Times and Gazette*, January, 1852.

[§] Ibid., August and July, 1865.

FIG. 528.



Sub-periosteal excision of the whole shaft of the tibia, for necrosis, yielded a successful result in the hands of Mr. Christopher Heath; the limb being shortened by only one quarter of an inch, and nearly two inches larger in circumference than on the opposite side. The patient could walk without support.*

CHAPTER XL.

AMPUTATIONS.

GENERAL DIRECTIONS.—Amputation is the removal of any part of the body by a cutting operation of severation. This kind of operation relates chiefly to the Limbs. It may be practised for Injury or Disease; but amputation is performed in a *sound* part, more or less remote from the seat of the morbid condition; Pathology only *negatively* guiding the operation in the selection of that part, yet thereby materially affecting the result.

The conditions of Injury or Disease, which necessitate Amputation, I have already considered in previous chapters—especially with reference to Contused Wounds, Compound Fractures and Dislocations; it remains only to here describe the operations themselves.

Certain direction are common to all Amputations.

Instruments.—Few and of simple construction, amputating instruments and appliances comprise—a tourniquet, Petit's (Fig. 529), for preventing hæmorrhage by compression of the main artery; Esmarch's bandage and elastic coil; amputating knives, of various lengths and shapes (see figures of operations); a saw (see figure, amputation of thigh), and cutting-pliers (see Fig. 315), the latter for removal of any spiculum of bone; artery-forceps (see Fig. 91) or tenaculum, for seizing or hooking arterial vessels; ligatures (see Fig. 91) or acupressure-needles and wire (see Fig. 92), for tying or compressing them; suture-needles and silk or wire (see Fig. 86); strips of diachylon or isinglass plaster, and roller bandages, sponges and lint, with a supply of cold water, are of course included among the requisite surgical appliances. A few minutes' personal examination of these instruments will enable the youngest student to understand them far better than by any lengthened description. Some of the instruments are not absolutely necessary, or comparatively seldom requisite. A tourniquet may be dispensed with, provided pressure be made on the main artery by the thumb of a steady assistant; and pressure can thus be made higher up in the limb than by means of a tourniquet, as in amputation at the upper third of the thigh. The advantages of a tourniquet are, that it compresses the smaller arterial vessels as well as the main trunk—the band portion encircling the limb, and that the compression of the pad is uniform and unfailing; the disadvantage is, that it also arrests the venous circulation, thus causing a greater loss of venous blood. This may be avoided by not screwing up the instrument tightly until just before commencing the operation. But Esmarch's bandage and elastic coil are now more commonly used than the tourniquet. The limb having been elevated for two or three minutes, thus by gravitation to reduce the quantity of blood in it, the roller is applied, with uniform compression, from the foot upwards to where the artery is to be compressed; then, a cork-pad being placed upon the artery, the elastic coil is drawn around the limb over the pad, by one or two turns, as may seem necessary, and the coil secured by a wooden groove-catch. Before applying the coil, the skin may be protected with a layer of lint. Cutting-pliers will not be required unless the bone be allowed to snap by dropping the distal portion of the limb, before the saw has passed completely through the bone. A tenaculum can be needed only where the artery must be "dipped" for; as an interosseous artery in the angle of two bones, just below the knee or elbow joint, in amputations of the leg or forearm at these parts. Ligatures may be set aside if acupressure-needles be used; or both dispensed with, by torsion of the vessels.

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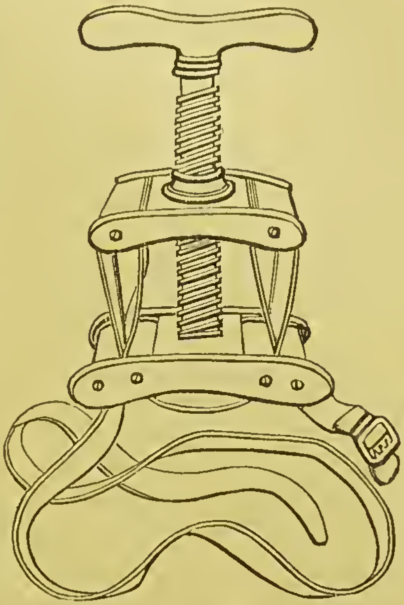
* "Trans. Clin. Soc.," 1877.

FIG. 529.



The instruments should be arranged on a small table or tray close at hand to the operator, or the assistant handing them to him; and he should *himself see* that everything is prepared before he begins the operation. This injunction applies equally to all Surgical Operations.

Assistants are required, varying in number according to the magnitude of the amputation; one assistant specially to administer chloroform, another to command the artery, a third to retract the flaps, and a fourth to support the limb, and, after its removal, to apply the ligatures, if used, as the arteries are seized by the operator. Thus the operation will be conducted in an orderly manner. In an emergency, fewer assistants will suffice, if they be instructed to do double duty.

Operation of Amputation.—Two forms of Amputation are practised: flap amputation by transfixion and cutting two flaps outwards, or one inwards and the other outwards, as regards the passage of the knife; circular amputation, by cutting from the skin towards the bone by a circular sweep of the knife, successively applied, with retraction of the divided integuments, or by two oval semicircular sweeps, progressing in like manner towards the bone. A combination of these two methods is sometimes practised; as by a single long flap on one aspect of the limb, and a transverse incision on the other side—Teale's amputation, or amputation by a long and a short *rectangular* flap.

The *flap* amputation will be described so thoroughly in particular amputations, as of the thigh, that it would be superfluous to introduce it here.

The *circular* amputation may be conveniently noticed once for all. The preliminary arrangements having been made as for a flap amputation, the Surgeon stands in the relative position necessary to grasp the thigh—for example, with his left hand just below the part where he is about to amputate; the integuments must then be drawn up by an assistant, who grasps the limb with both hands. Holding the knife lightly, but securely, the operator passes it under the thigh, bending his hand back until the edge of the knife lies on the inner and anterior surface of the thigh. (Fig. 530.) Sinking the edge through the *skin*, he carries it deliberately round under the limb, and then over it, gradually changing the bend of the wrist, until the hand is as much inclined forwards as it was in the opposite direction; and thus completes a circular incision. Whatever be the extent of retraction produced, the integuments should still be drawn upwards, evenly around the limb; the knife is again applied as before, at the line of retracted integuments (Fig. 531), and made to sweep round the limb, passing half an inch or more through *aponeurosis* and superficial muscular fibres. The assistant, continuing to draw upwards, presents a fresh surface high up, and passes his hands down into the wound to secure the surface already gained; a third time the knife is made to encircle the limb, at the upward line of the second incision, dividing the *muscles*, large blood-vessels, and nerves, down to the bone. Retraction being continued by the assistant, some muscular fibres may be made to appear, attached to the bone for an inch or more above the line

FIG. 530.

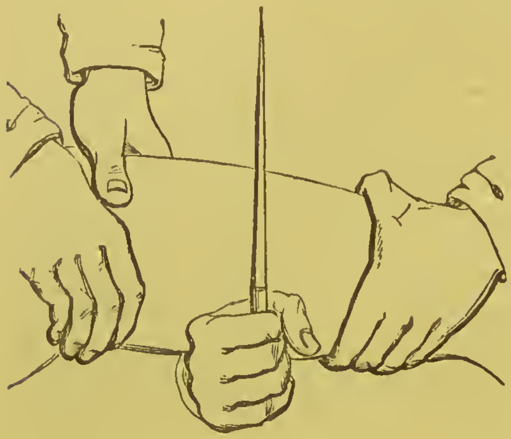
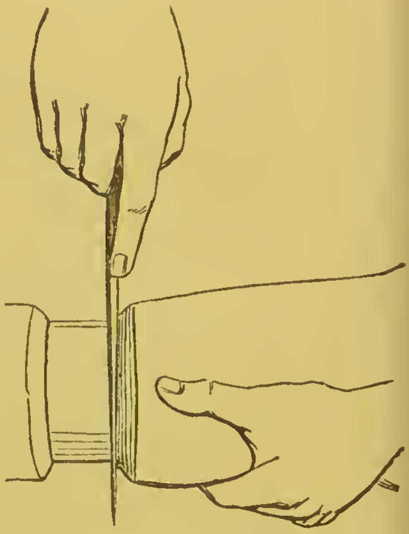


FIG. 531.



where the knife first touched the periosteum; these are divided with the point of the knife. The saw must then be applied at the highest part where the bone is exposed, and the bone sawn across transversely; the saw being worked freely from point to heel, and not fiddled irregularly. In making retraction deep towards the bone, it will generally be requisite or advantageous to employ a retractor—a broad piece of linen, with a longitudinal slit in it; this appliance proving more efficient than the fingers. In practising circular amputation on the dead subject, the flaccid state of the muscles, as contrasted with their tonicity during life, even under the influence of chloroform, will render it unnecessary to employ a retractor or to use the more forcible manual retraction, above directed; but this difference only affords another illustration of the general distinction between operations on the dead and the living.

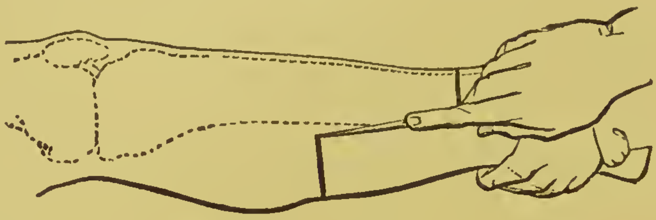
On allowing the integuments and muscles to fall down and regain their position, a conical cavity is formed, sloping gradually from the circular line to the skin, as the base, up to the bone, as the apex of the cone; presenting a loose but fleshy stump. The vessels are secured, and the integuments adjusted by sutures, as in the flap amputation.

A *modification* of the circular mode of amputation was introduced by Mr. Syme (1846). It consist of forming *two semilunar* incisions through the *integuments*, which are dissected and retracted upwards for at least two inches; then cutting the muscles on a level with the retracted skin obliquely up towards the bone, the muscles on the posterior aspect being divided at a somewhat lower line. All the soft parts are then well retracted, and the bone cleared and sawn at its highest point. This is sometimes known as "the mixed method of amputation"—a combination of the flap with the circular methods; and it may be performed by means of lateral, or of antero-posterior flaps. It is equally well adapted for amputations in the upper or lower limb, and especially in the leg or the forearm.

The *relative merits* of these two modes of amputation have been much discussed; and some Surgeons have practised almost exclusively the one, and some the other, operation. Mr. Liston advocated flap amputation, and Sir W. Fergusson seemed to prefer it, although fully acknowledging the good results of circular amputation in the hands of many excellent Surgeons. I am a disciple of the former distinguished Surgeon, originally as my teacher; and having performed the flap amputation almost invariably, for many years, with ease, and the production of permanently good stumps, I am inclined to recommend its general adoption. Professor Spence, who has paid great attention to the subject of amputation, gives the preference to the flap operation, as compared with the circular method, subject to certain modifications of the former method. The two modes of amputation may perhaps be thus estimated :—flap amputation is decidedly more easy of execution; circular amputation has sometimes the advantage of a more successful result in a good stump. Both, however, may prove equally satisfactory in this respect, with care during the operation, in the formation of the stump, and in the subsequent dressing. Flap amputation is decidedly superior at any joint; and circular amputation in the continuity of a bone, when the limb is unusually fleshy. I have sometimes overcome the difficulty of redundant flaps, by passing the knife above and below the bone, in making the flaps, so as to leave a wedge-shaped portion, and thus reduce their bulk; or, it may even be allowable to slice off a portion of muscle, after having formed the flap, rather than leave a redundancy. But this I have very rarely done, except when the muscle was evidently damaged by contusion, above the part to which the injury had apparently extended, upon external examination of the limb.

Amputation by a Long and Short Rectangular Flap—Teale's Operation (1858).—The object of this method of amputation is twofold—to procure a more useful stump, and to diminish the mortality of the operation. Accordingly, the long flap is formed from that side of the limb which does not contain the principal blood-vessels and nerves, and is made long enough to fold easily over the end of the bone, its length and breadth being equal to half the circumference of the limb; while the short flap is one-fourth its length, and contains the vessels and nerves divided transversely. (Fig. 532.) No dressing is used, and the stump should not be lifted for many days.

FIG. 532.



Spence's *modification* of this operation (1858) consists in making the anterior flap only of such length that it shall not double on itself, and of such shape, being rounded off, that it shall fit more evenly to the curve of the posterior segment of the stump. The posterior incision is begun two inches lower down than the base of the anterior flap, and the bone is cleared with a circular movement of the point of the knife, and sawn through two inches higher up than the base of that flap.

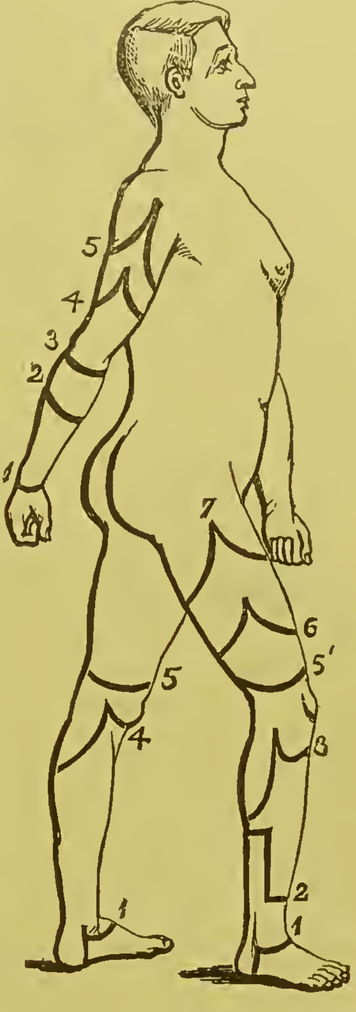
Carden's Amputation at the Knee-joint (1863), and *through the Condyles*, is designed on the same principle, the incisions being nearly similar, as will be explained more particularly in describing special amputations.

Relative Merits of these Methods of Amputation.—The advantages of Teale's amputation are—the prevention of tension by the ample size of the long flap; that, folding over the end of the bone, the flap soon acquires organic union therewith, and closes up the exposed veins; that, the limb remaining undisturbed by lifting and dressing, early closure of the veins is thus also favoured; that the end of the bone is covered by a flap free from large nerves and blood-vessels, and that the cicatrix does not adhere to it. The disadvantages consist in the necessity of sawing the bone at a higher point when one long flap only is made, than when two shorter ones of more equal length are fashioned—thus violating the established rule of not removing a limb at a higher point than is absolutely necessary, and impairing also the utility of the stump whenever its length may be a consideration of consequence. In many injuries, with much damage to the soft parts, the operation would be impracticable, and the increased danger of a higher amputation would have to be encountered.

In malignant or other recurring disease, the risk of recurrence in the long flap would be far greater than in two shorter ones, the bone being sawn at the same level. If primary union fail, the bulging of the large anterior flap will be more unmanageable than that of the two smaller flaps.

The apparent advantages of Professor Spence's modification of this operation are—that the anterior flap is less liable to slough, and in after-dressing it tends more to lie in position; while the section of the bone being above the lines of both incisions, affords a deeper and more permanent covering to the bone-end, with less exposure of cut surface. Moreover, an anterior flap of four inches in length will suffice where the limb is twelve inches in circumference; whereas, in Teale's amputation, the flap in such a part would have to be six inches long; consequently, Spence's method is eligible in parts of a limb, and under circumstances where the other amputation could not be performed. In the lower third of the thigh, more particularly, this modified Teale's amputation is specially suitable.

FIG. 533.*



The form of the flaps in the common amputations, as performed in both the upper and lower limbs, is here delineated. (Fig. 533.)

STUMPS.—A *good stump* comprises certain essential requisites:—that the bone be provided with ample covering of soft textures; and so formed that the bone-end shall not bear directly on the line of union in the resulting cicatrix; that the nerves be divided sufficiently high up to prevent their extremities becoming adherent to the bone-end or to the cicatrix, and, being thus deeply covered, to protect them from external pressure, and from atmospheric influence.

Dressing of a Stump.—The general plan of putting up a stump, and after-dressing, is as follows:—Supposing, for example, it be a stump of the thigh, the flaps or wound should be well cleansed of any blood or chance foreign matter, by gently sluicing the surfaces with cold water squeezed from a clean, fresh sponge, a basin catching the streams underneath the stump. A weak solution of carbolic acid may be used, in like manner, as an antiseptic. The surfaces must then be adjusted, so that the edges lie evenly and easily in contact when brought together.

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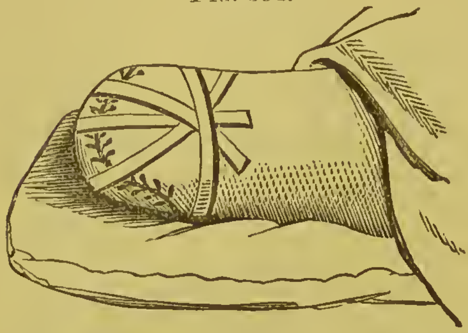
* Figure showing lines for the formation of flaps in amputation.—Upper extremity: 1, at wrist-joint; 2, in forearm; 3, at elbow-joint; 4, in arm; 5, at shoulder-joint. Lower extremity: 1, Syme's amputation at ankle-joint; 2, Teale's amputation, in the leg; 3, amputation of leg; 4, at knee-joint; 5, in thigh, Vermale's amputation by lateral flaps; 6, amputation by antero-posterior flaps; 7, at hip-joint.

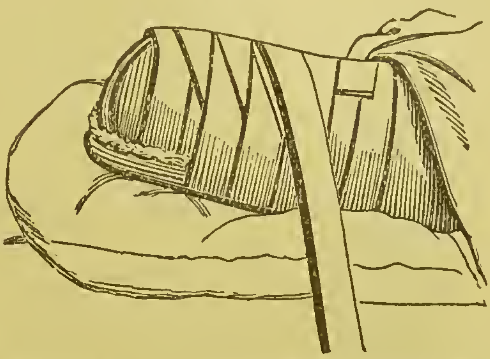
Any ligatures, or acupressure wires, when either are used, should be drawn out at the nearest angle of the wound, and gently held under the finger of the assistant in charge of the flaps. Sutures or stitches are employed to retain the edges in apposition. Commencing most advantageously, for equal shaping of the stump, by introducing the first suture-needle in the middle of the stump, it should transfix either lip at about half an inch from the margin, so as to bring together a sufficient thickness of integument to support the flaps and induce primary adhesion. The thread is drawn through, and—as the assistant holds the integument together, tucking in any extruding fat or muscle, which, if allowed to intervene, would prevent primary union of the skin—the suture-thread is tied, without slipping, in a double knot, and the ends snipped off close to the wound. Other sutures are introduced in like manner, on either side of the first; and as many as may be necessary—no more—to keep the flaps together throughout the line of union. At one or both angles of the wound, as may be convenient, the ligatures having been collected are protected from disturbance by a small strip of plaster overlaying them. Strips of adhesive plaster are sometimes drawn around the end of the stump, in the intervals of the sutures, thus further supporting the flaps, if bulky, and favouring adhesion. (Fig. 534.) The position of the stump for the free drainage of discharge, is also shown in the case I have here represented. A strip of lint soaked in carbolic acid solution, or smeared with spermaceti ointment or carbolic oil, is laid along the whole length of the wound, and cross-strips, each about two inches wide, are applied, from the under to the upper surface of the whole stump, extending about six inches on either surface, and retained in position by a long and broad strip carried around their ends; lastly, a roller-bandage is applied, so as also to encase the stump, but with a moderate degree of pressure. This is done by first carrying the roller, in two or three turns, around the stump, over the circular strip of lint; then, an assistant grasping the stump with both hands, above and beneath, the bandage is reflected from the middle of the upper surface, and carried downwards over the end of the stump to the under surface, where it is reflected again, each turn being caught and held in position on either surface by the fingers of the assistant; these cross-turns are repeated all over the end of stump, in a radiating manner, so as to form a complete case, and then the duplicatures on either surface are secured by two or three circular turns of the bandage. Sometimes, a hæmorrhagic tendency is evinced by oozing of blood; the roller should then be applied more tightly for a time, or a compress of lint above and below the flaps may be advisable as an additional support and security, in putting up the stump.

FIG. 534.



On placing the patient recumbent in bed, the stump should be supported and elevated on a pillow, covered with a draw-sheet of mackintosh cloth, a cradle being used to remove the weight of the bed-clothes. If there be no hæmorrhage, the stump should be left undisturbed for some days—two, three, or even four days, according to the degree of tension, the appearance of discharge, and atmospheric conditions as to temperature or otherwise. Meanwhile, any liability to disturbance by spasmodic jerking of the limb may be controlled by a roller turned once round the stump and fastened to either side of the bed. Opiates may also be administered, if necessary, for this purpose, and to procure sleep. To more effectually support the flaps of the stump, and to counteract any tendency to spasm, a short back-splint is often used with great advantage (Fig. 535); and, indeed, I seldom dispense with it, particularly after amputation below the knee-joint, where the stump is subject to the action of the quadriceps extensor muscle inserted into the tubercle of the tibia. In the case here figured I had performed a supra-condyloid amputation.

Fig. 535.



Re-dressing the stump must be done gently. By sliding the hand beneath the stump, it is lifted up, and the draw-sheet and pillow removed for the nurse to clean; then, a flat pan being placed to receive any discharge, the roller is slit up with scissors, and the strips of plaster are to be removed and replaced one by one, leaving those that still retain a good hold, and probably all the sutures. In removing each strip, it should first be moistened with a piece of wet lint—preferable to sponge, which is apt to be re-used in another dressing, or perhaps from another patient—and both ends of the strip should be withdrawn together towards the lips of the wound, so as not to disturb the as yet recent union. Care must be taken not to disturb the ligatures. The discharge should be gently syringed out with weak carbolic acid solution. A fresh strip of lint dipped in water—water-dressing—is reapplied, or a solution of carbolic acid, as an antiseptic, and over all, the support of a roller, lightly and evenly applied, will still be requisite. Subsequent dressings may be reduced and made yet lighter, their reapplication having regard especially to the counteraction of any tendency to *bagging* by the collection of matter. Ligatures should be removed as they loosen from time to time; or acupressure-needles may be withdrawn in three or four days after amputation.

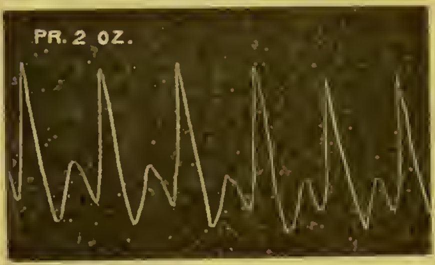
Any modifications of these proceedings, or further details, will be suggested by a general knowledge of the management of Wounds.

Morbid Conditions of, or affecting, the Stump.—(1.) *Secondary Hæmorrhage.*—Hæmorrhage is named secondary when it occurs after an interval of a few hours, more or less, subsequent to an injury. It may arise from local or constitutional causes. *Local* causes comprise the misapplication of a ligature, as when, not having been applied transversely, or when, having included some surrounding texture, it shifts its position or loosens; a collateral branch just above the ligature may be the source of hæmorrhage, if wounded, or lead to hæmorrhage from the ligatured vessel by disturbing the formation of a clot. In the one case, hæmorrhage occurs soon after ligature; in the other, when it separates. A diseased state of the coats of the artery ligatured is also followed by hæmorrhage. *Constitutional* causes include reaction after the stump has been put up, many vessels not bleeding at the time the main trunk was ligatured, and even this vessel will not bleed in a state of great collapse; excessive reaction has the same effect; an aplastic state of the blood will delay and impair the formation of clot within the vessel; and blood-poisons also have this effect, or, by inducing erysipelas or sloughing of the wound, the result is the same—secondary hæmorrhage.

The *phenomena* of such hæmorrhage are not, as with primary arterial hæmorrhage, a jetting stream of florid blood; but, after a while, the blood wells up from the wound, and oozes through the dressings, then ceasing perhaps, it recurs again in a few hours. A stump should, therefore, always be watched for some time after amputation; and in the event of blood oozing, its continuance should be tested by sponging the part dry and overlaying it with a piece of dry lint, so as to detect any further escape. *The period* when secondary hæmorrhage occurs is variable; separation of the ligature is always a time for vigilance.

"Hæmorrhage, by reducing the volume of the blood, produces low arterial tension, and consequently a more or less dicrotous pulse in proportion to its amount. Unless the loss of blood has been very great, the volume of the blood expelled at each ventricular contraction is not much, if at all diminished; but the emptiness of the vessels allows the pulse to collapse rapidly: hence the characteristic 'splash pulse' associated with this condition. The pulse reproduced in the figure (Fig. 536) had this character remarkably developed; the dicrotic beat also was perceptible to the finger."*

Fig. 536.



Treatment must have reference to the presumed cause of hæmorrhage, as mainly determined by the period of its occurrence. *Early* secondary hæmorrhage—within a few hours or days—may generally be suppressed by elevating the stump, and the application of cold and pressure to the flaps, a compress above and below being used and the bandage tightened. This failing, the stump must be opened up, the vessels sought for and tied, and the flaps replaced when the bleeding is controlled. *Later* secondary hæmorrhage—after ten days or a fortnight—proceeds, more probably, from the main artery in the stump; a ring tourniquet applied to that vessel above the stump will perhaps arrest the bleeding: this failing, the stump may be opened up, the coagula turned out, and the vessel sought and tied; or a ligature applied to the vessel above the stump. The choice between these two latter proceedings should be determined by the state of the stump, as regards the soundness or the unsoundness of the union. In the one case the vessel should be sought *in situ;* in the other, *above* the stump. Ligature *high up*, as by the Hunterian operation, may even then be requisite. In the event of any failure in arresting the hæmorrhage, these different proceedings should be had recourse to *successively*. If, from the probable pre-existence of some causative condition, there be a liability to secondary hæmorrhage after amputation, or other operation, it will be a judicious precaution to place a tourniquet around the limb loosely, which can be tightened at any moment by the special nurse in attendance; or, by marking with ink the spot where pressure should be made in the course of the main artery, the nurse can be instructed thus to arrest the bleeding. Even the patient may become an assistant, when necessary.

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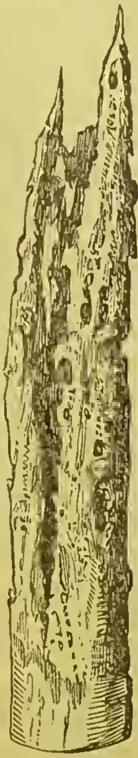
* "The Pulse after Severe Hæmorrhage," note by Dr. Mahomed.

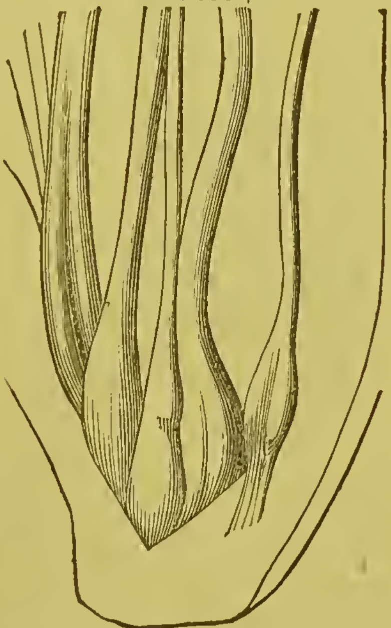
(2.) *Necrosis.*—Death of the end of the bone, and a resulting sequestrum or exfoliation, may take place, either from injury to the bone by rough use of the saw, or in consequence of suppuration, sloughing, and exposure of the bone. The dead portion must be removed, when loosened. But the whole shaft of the bone may become necrosed, as happened in a case of a femur, after amputation in the thigh; and of which the specimen will be found in the Museum of the Royal College of Surgeons. In such a case, re-amputation higher up would be the only resource.

Fig. 537.*



(3.) *Conical Stump*, with protrusion of the bone.—This morbid condition arises, either from insufficient coverings of the bone at the time of amputation, or from spasmodic retraction of the muscles subsequently. In either way the bone projects, and the stump has, or acquires, a conical shape upwards from the bone as its *apex*. Sometimes, the bone threatens to protrude under a thin ulcerative cicatrix, which is unable to bear the slightest pressure or motion. Growth of the bone, in young persons, is apt to give rise to conical stump eventually, as specially noticed by Hargrave and Spence. But in all the amputations I have had, only three have been followed by conical stump, each of which resulted from spasmodic contraction.

Fig. 538.†



The protruding or projecting portion of bone must be excised, and the stump refashioned. An incision on the side opposite to the vessels should fairly expose the bone, which is then sawn off, and the flaps readjusted. In an extreme case, amputation of the stump must be resorted to.

(4.) *Neuralgia* of the stump may arise from local or constitutional causes. Commonly, it arises from a more than usually bulbous enlargement of the ends of the nerves in the stump (Fig. 538), or from their adhesion to the cicatrix, or to the end of bone, whereby also they are subject to external pressure or to atmospheric influence. Excision of any such enlargement will be necessary, or subcutaneous division of an adherent cicatrix. The end of the bone should be removed, to relieve pressure and tightness arising from that cause. In a case of painful cicatrix after Chopart's operation, I divided the cicatrix subcutaneously without much effect; but at a later period, I removed the subjacent portion of the astragalus, with a perfectly successful result. The tendo-Achillis had been divided, to overcome retraction of the stump and tilting forwards of the astragalus under the cicatrix. An hysterical constitutional condition not unfrequently causes neuralgia and spasmodic twitchings in the stump, especially in females. No operative interference will be of the slightest use; and this condition must be treated, as best it may, constitutionally. In more rare cases a neuralgic affection of the stump, coupled perhaps with spasmodic contractions of the muscles, may depend on the formation of an *exostosis* at the end of the bone. This had occurred in a case, after amputation in the thigh; the end of the femur being the seat of two osseous outgrowths, attached near the linea aspera. (Roy. Coll. Surg. Mus., 2827; also 2826. G. Langstaff.)

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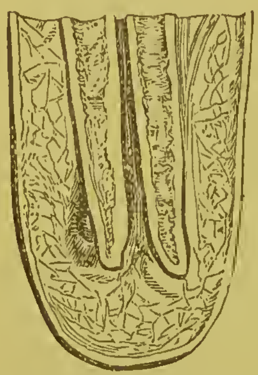
* Royal Free Hospital Mus.

† After Froriep.

Healthy Stump.—Certain structural changes ensue in a healthy stump, and whereby it presents ultimately an altered appearance. The ends of bone or bones become rounded and somewhat pointed, or occasionally enlarged, at their extremities, and the medullary canal is occluded with new bone. The ends of two bones, as in stumps of the leg and forearm, are usually approximated and connected by strong ligamentous union, or sometimes joined by an osseous arch (Spence). The vessels are obliterated up to the nearest collateral branch, and the ends of the nerves have undergone some bulbous enlargement, consisting of dense fibro-cellular tissue and scattered nervous fibrillæ—these terminal neuromata forming even when the ends of nerve are deeply covered. The muscular portions of the flaps, however ample at first, are more or less wasted and transformed into fibro-cellular texture connected with the skin, which chiefly forms the covering to the bone. Commonly, the end of bone corresponds to the cicatrix, and is often firmly united to it; but both these conditions will depend on the mode of forming the covering. The stump is thus reduced in size and somewhat pointed or conical; the rounded end of bone being plainly felt under the finger. (Fig. 539.) The practical inferences from these structural results would seem to be, that bulky muscular flaps are useless, and that the skin should be made of amply sufficient length to form the integumental covering of the bone; at the same time, observing to divide the nerves high up, to prevent their ends becoming involved in the integumental cicatrix, and to afford a deep covering as the muscular texture progressively wastes to a greater or less extent. In *young* persons, the bone may continue to grow after amputation. Consequently, in performing the operation, some redundancy of soft parts should be left to compensate for the osseous development.

FIG. 539.*



Artificial Limbs of various kinds have been invented, suitable to the use of the part removed; and the most useful forms are figured in connection with the result of each particular Amputation.

DOUBLE AMPUTATION.—Amputation of two limbs, simultaneously or in immediate succession, may occasionally be required for severe injury, and sometimes for disease, as gangrene. The lower extremities are more frequently subject to double amputation, as when both thighs are crushed by the passage of a railway-truck across them; or one leg and one arm may have to be removed; but both arms seldom require amputation. I have had occasion to amputate both lower extremities, below the knees or in the thighs, in some instances; or the lower extremity, in the thigh, and the upper at the shoulder-joint; but I cannot call to mind having had occasion to amputate both arms.

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* Roy. Coll. Surg. Mus., 2814A. (Partridge.)

The choice of simultaneous or *subsequent* amputation must be determined by the state of shock to the nervous system and the circulation. The object of simultaneous amputation is to lessen the repetition and persistence of shock, by making it the shock, as it were, of one operation. But the reserve-power of the system to sustain this single, more severe shock must be judiciously estimated; and if subsequent amputation be deemed the safer course, the period of interval between the two operations—amputation of one limb, and then the other—should be regulated by the same consideration. In simultaneous double amputation of the lower limbs, Lister's tourniquet for compressing the abdominal aorta offers the advantage of allowing the immediate succession of the second operation, without waiting to ligature the vessels in the first stump,—a procedure which involves no shock to the system.

Results of Amputation.—The *mortality* after Amputation may be *primary*,—from shock; or arise from *secondary* causes;—principally secondary hæmorrhage, exhaustion, tetanus, pyæmia, phlebitis, erysipelas, and pneumonia, or other visceral affections, and from affections of the stump, as sloughing, and hospital gangrene.

The *causative conditions* which give rise to and induce these immediate causes relate: (1) to the constitutional conditions, and age, of the individual; (2) to hygienic conditions; (3) to the operation;—as for injury or disease, the kind and extent of either, the period after injury,—representing primary and secondary amputations, the seat of amputation in its proximity to the trunk, and the structure of the bone sawn through, as involving or not the medullary canal.

(1.) *Individual Conditions.*—*Constitutional* states of health, whether hereditary or acquired, have a most powerful predisposing influence on the mortality after amputation, as after operations in general. A naturally *weak* constitution, whether in regard to the nervous system, the quality of the blood, as in the scrofulous diathesis, or the vigour of the circulation, predisposes to the severity of shock contingent on the operation, to passive hæmorrhage, or to exhaustion. An acquired state of the general health, of similar character, in consequence of habits of intemperance and a hard life, resulting in a *broken* constitution, has the same unfavourable influence after amputation. Of *organic* diseases, the one which has perhaps the most fatal tendency is Bright's disease of the kidneys, with albuminuria; a disease whereby the blood becomes drained of its albuminous or reparative plasma, and poisoned by the retention of urea or excrementitious matter. *Age* affects the result of amputation; the probability of success being in favour of an early period of life, and declining as life advances. In the one case, death occurs more frequently, by the exhaustion consequent on acute inflammatory fever, soon after the operation; in the other case, exhaustion from shock or from blood-poisoning, soon after the operation or at a later period.

(2.) *Hygienic conditions* relate principally to an impure atmosphere, as arising from deficient ventilation, defective drainage, or want of personal cleanliness; and to zymotic influences; also to the food, in respect to its quality and quantity. It is mainly on account of impure atmospheric conditions that the mortality from amputations in large towns contrasts unfavourably with those in the country. And the causes of death are different: in towns, exhaustion, tetanus, pyæmia, erysipelas, and hospital gangrene; in the country, hæmorrhage and acute inflammation. But there is reason to believe that the principle now observed in the best Metropolitan Hospitals,—the segregation instead of the aggregation of patients, will tend to equalize the relative mortality after operations in town and country. At the Royal Free Hospital, where this principle is rigorously observed, pyæmia, for example, is of very rare occurrence.

(3.) (*a.*) The *operation* itself, as to whether the amputation be performed for *injury* or *disease*, is followed by a very different rate of mortality, and in favour of disease. Thus, the mortality resulting from amputation in the thigh and leg, as performed in the Provincial Hospitals, differs considerably under these circumstances; being, in regard to the thigh, 61 per cent. after amputation for injury, and only 23·4 per cent. after amputation for disease; and in respect to the leg, 40 per cent., as compared with 25·5. In the Parisian Hospitals, Malgaigne's statistics show less disproportionate results between the operation for injury and disease; in the thigh, 74 per cent., and 60 per cent.; in the leg, 63·3, and 49. But, after amputation of the foot, the proportionate mortality was 66·6 per cent., and 10·3 per cent.; and after the operation in the arm, 56·6, and 6·5. In University College Hospital, the results of 274 cases of amputation in the thigh, leg and foot, shoulder and arm, and forearm, presented the following total proportion of mortality:—For injury, in 92 cases, 36 deaths, or 39·1 per cent.; for disease, in 182 cases, 30 deaths, or only 16·5 per cent. Professor Spence has recorded the results of his amputations in 403 cases, in the lower and upper extremities:—For injury, 144 cases, with 60 deaths, or rather less than 1 in 2; for disease, 259 cases, with 50 deaths, or less than 1 in 5. These results exclude all amputations of less magnitude than those at the wrist and ankle joints.

The *causes* of the greater relative mortality after amputation for injury would appear to be the greater severity of the shock, the tendency to pyæmia, the liability to tetanus, or to gangrene of the stump; whereas, exhaustion or pneumonia would seem to be the chief causes of a fatal result from amputation for disease. The *kind* and the *extent* of the local condition has also an unquestionable influence on the result of the operation; as illustrated by the importance of compound and comminuted fracture, and of malignant disease, in relation to their mortality after amputation. With regard to disease, a chronic state of the morbid condition is least unfavourable for operation; as is well illustrated by the results of excision of the joints and bones.

(*b.*) The *period after injury* least unfavourable for amputation has led to the distinction of *primary* and *secondary* amputations; the one being performed within the first twenty-four hours, or before the supervention of inflammation; the other, after that period, when inflammation has supervened, or, at a later period, suppuration. The results of primary and secondary amputations differ in Civil and Military practice. In *Civil* practice, the mortality from primary amputations is rather higher than from secondary amputations; but in a variable proportion according to whether it be the *lower* or the *upper* extremity. In the 403 cases by Spence, of the 144 submitted to amputation for injury, there was an equal proportion of 72 in each extremity. In the lower limb, 58 primary amputations were followed by 33 deaths, and 14 secondary by 8 deaths. But in the upper limb, of 60 primary amputations, 16 only were fatal; and of 12 secondary, only 3. In the lower extremity, therefore, both primary and secondary amputations are most fatal. Of 46 cases recorded by Malgaigne, 34 died. Of 24 cases recorded by South, Laurie, and Peacock, as having occurred in old St. Thomas's Hospital, the Glasgow and Edinburgh Infirmaries, all were fatal. The *total* results of amputations in the thigh, leg and foot, shoulder, arm, and forearm, as performed at University College Hospital, may be thus compared:—Of primary amputations, in 48 cases, there were 18 deaths; of secondary amputations, in 43 cases, 19 deaths. In *Military* practice, the mortality is reversed; secondary amputations, excepting those of the hip-joint, being far more fatal than primary operations. Of 300 secondary amputations by Faure, only 30 recovered; whilst three-fourths of Larrey's primary amputations recovered. With regard to whether the operation be performed in the *upper* or the *lower* extremity; during the Peninsular War, the mortality after secondary amputation in the one case was twelve times, and in the other only three times, as great as after primary amputation of these parts; a difference more adverse to secondary amputation in the upper limb. The *seat* of operation in the upper and lower limbs affects the mortality, as shown by the results in the British army during the Crimean War. The relative rate of mortality per cent. was as follows:—From primary amputations: at the shoulder, 27; of the arm, 17; of the forearm, 3; of the thigh, 62; of the leg, 30; and of the foot, 17. Then again, from secondary amputations, the death-rate per cent., in different parts, was—at the shoulder, 66; of the arm, 31; of the forearm, 28; of the thigh, 80; and of the leg, 76.

The *causes* of death, as well as the rate of mortality, differ after *primary* and *secondary* amputations. The former are more often fatal from shock, hæmorrhage, exhaustion, and perhaps tetanus, or pyæmia; the latter period of operation is especially prone to a fatal issue from exhaustion, tetanus, pyæmia, erysipelas, pneumonia, or other visceral affections, and gangrene of the stump. Statistical results are wanting to accurately determine the relative frequency of these causes of death, with reference to the period of amputation.

(*c*.) The *seat* of amputation, in relation to the mortality of this operation, is very important. The danger and the death-rate are greater in proportion to the proximity of amputation to the trunk; and in an increasingly ascending ratio, the higher the line of operation, and the larger the size of the part amputated. Common surgical experience shows that the removal of a toe or finger is less hazardous than amputation of the thigh or arm. But statistical results have shown the regularly ascending mortality according to the line of amputation. Thus, in the American War, the percentage of mortality rose as follows:—Fingers and hands, 1·5; wrist, 5·5; forearm, 16·5; arm, 21; shoulder, 39; partial of foot, 9; ankle-joint, 13; leg, 26; knee, 55; thigh, 64; and hip, 85. Some relation subsists between the proximity to the trunk and the causes of death from amputation. Thus, the removal of a limb high up is more fatal from shock, or from hæmorrhage, primary or secondary.

(*d.*) The *structure* of the bone sawn through, when the medullary canal is opened, seems to have some degree of unfavourable or even fatal influence; owing to the liability of consecutive suppurative inflammation of the medullary membrane,—osteo-myelitis, and pyæmia. But the importance of this condition relatively to the mortality after amputation, is very undetermined.

Particular Amputations.

Amputations of the Upper Extremity.—The Hand. (Fig. 540.)—*The Fingers, at their Phalangeal Articulations*, not unfrequently require amputation for injury or disease, as caries resulting from whitlow. This operation is very simple. The hand being held prone, and the fingers on either side of the affected one drawn towards the palm by an assistant, the operator lays hold of the end of the finger, and bending it slightly, he applies a narrow-bladed bistoury or scalpel to one side of the joint, opposite the articulation (Fig. 541), and carrying it over to the opposite side, makes a slightly convex incision, directed downwards; then, running the knife across and through the joint, bending it as needs be, the blade is turned flat under the phalanx, and a semilunar flap made of sufficient length to cover the extremity of the bone and unite with the dorsal incision. *Another* and *reverse mode* of doing this operation is—by placing the hand in the supine position, and with the finger extended, to transfix on the palmar aspect of the joint, and carrying the blade flat on the bone, cut a semilunar flap of sufficient length; then, passing the knife across and through the joint, to divide the skin almost transversely in bringing it to the surface.

Fig. 540.*

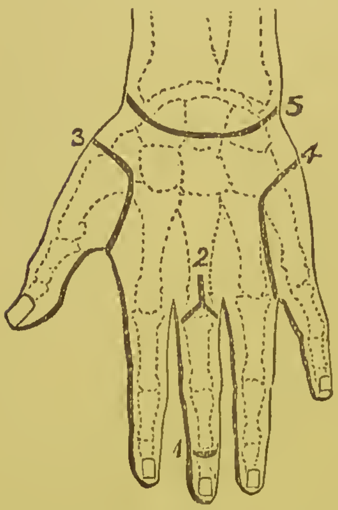
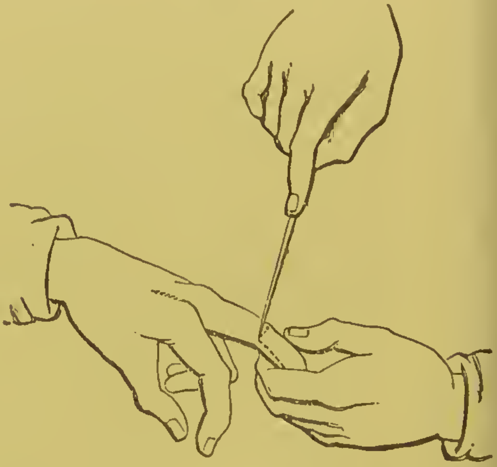


Fig. 541.



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* Diagram showing lines of incision from points of bone, in—1, amputation of phalanx of finger; 2, finger; 3, thumb; 4, little finger; 5, at wrist-joint.

Amputation *through any of the Phalanges* may be performed in like manner. And, instead of amputating at the articulation of the middle and metacarpal phalanx, it is better, having made a short dorsal and longer palmar flap, to cut through the middle phalanx with pliers; thus to leave the insertion of the flexor tendon to move the first phalanx, which would remain a stiff spike if the amputation were performed at the articulation.

Amputation of the entire Finger, at the Metacarpo-phalangeal Articulation.—Having placed the hand in the prone position with the fingers, on either side of the affected one, drawn towards the palm by an assistant, the Surgeon lays hold of the finger, and entering the point of a long narrow bistoury or scalpel on the dorsal aspect of the metacarpal bone, about half an inch above the head of this bone or knuckle, an incision is carried forward to the interdigital web, and round the palmar aspect of the finger; the knife is then turned obliquely backwards along the interdigital web of this side also, to join the dorsal incision. A kind of looped incision is thus formed, embracing the root of the finger from above the joint, and there including an angular portion of integument. The oval flap is easily drawn back, the extensor tendon divided across, and the finger disarticulated. (Fig. 542.) This, the *oval* method of amputation, may be converted into a V incision, by depressing the knife slightly into the palm, converging towards the middle line, then diverging again towards the web on the opposite side, and thence upwards into the dorsal incision. The resulting linear cicatrix is less puckered than by the oval method. A *third* method consists in directing the edge of the knife on the web, close to the finger, and by an incision backwards towards the middle line, on the dorsum and into the palm, the joint is reached; the blade is then passed round the head of the phalangeal bone, and brought outwards through the web on the opposite side. This method, though simple and rapid, requires practice. In either way, disarticulation is aided by using the finger as a lever. The bulky head of the metacarpal bone had better then be removed with bone-pliers, introduced from the dorsal surface (Fig. 543), and by nipping the bone cleanly across; unless it be the index or little finger, in regard to both of which the bone should be nipped across obliquely from without inwards, so as to conform to the outline of the hand. After tying or twisting the digital arteries, the edges of the incision readily fall together into a line, and the fingers being brought together, the gap is scarcely perceptible. A palmar splint is applied, and simple dressing as usual.

FIG. 542.

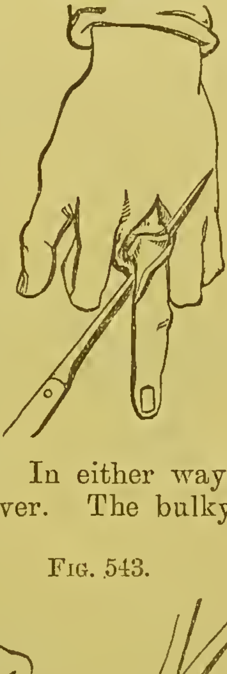
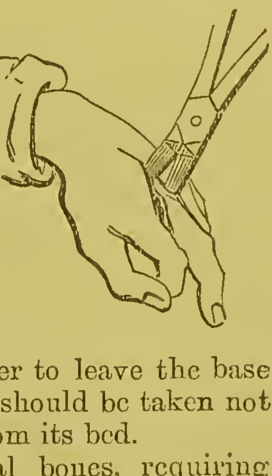


FIG. 543.

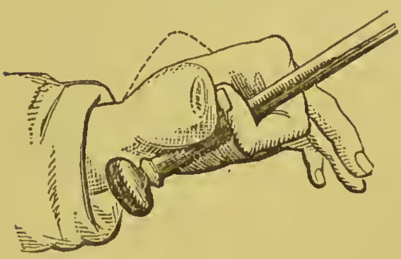


The *Metacarpal bone* may be included by carrying the incision further back; but it is better to leave the base of the bone,—not to open the wrist-joint, and care should be taken not to wound the palmar arch in removing the bone from its bed.

Several fingers, with perhaps their metacarpal bones, requiring removal for disease or injury, the operation can be fashioned in a similar manner, leaving a very useful forceps-hand.

Amputation of the Thumb, at its Metacarpo-phalangeal Articulation, is performed in precisely the same manner as for the removal of a finger at the same articulation; but, if possible, the head of the metacarpal bone should always be preserved, any remnant portion of the thumb being specially serviceable. Hence, the incision from the dorsal aspect must be carried forward on the radial side beyond the base of the phalanx, to obtain sufficient flap-covering for the bulky head of the metacarpal bone. The result of this amputation will often be very satisfactory; the ball of the thumb acquiring a considerable range of motion, and equal strength as an opponent to the fingers; both of which functions are shown in the use of the hand of a patient upon whom I had thus operated for injury to the thumb. (Fig. 544.)

Fig. 544.



Amputation of the Thumb, at its Carpo-metacarpal Articulation, is the only amputation peculiar to the thumb. *Liston's method.*—Commencing an incision just above the articulation of the base of the metacarpal bone with the trapezium on the palmar aspect, and continuing it down the dorsal aspect of the bone, inclining slightly to the radial side, the knife is sunk into the fold of integument between the thumb and forefinger (Fig. 545); then, introducing the knife at this extremity of the incision, and thrusting it up along the palmar aspect of the bone, its point is made to emerge at the commencement of the incision, and the palmar integument divided outwards (Fig. 546); observing to carry the blade forwards to opposite the dorsal incision, at the root of the thumb, that the palmar flap shall entirely cover the exposed surface of the web. The bone is twisted out, and disarticulated with a few touches of the knife; the lips of the oval wound form a single incision, and eventually a linear cicatrix. In operating on the right thumb, it will be necessary for the Surgeon to cross his hands in an awkward manner, unless he is ambidextrous. The order of amputation may, therefore, be reversed; first, by transfixion, the palmar flap is made, and then the dorsal incision. *Another method* consists in carrying the dorsal incision downwards to within half an inch of the metacarpo-phalangeal articulation, and then in an oval form around the joint, up to the dorsal incision. When the flap is brought together there will still be only a single line of cicatrix.

Fig. 545.

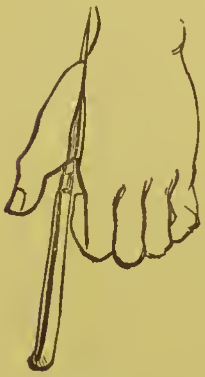
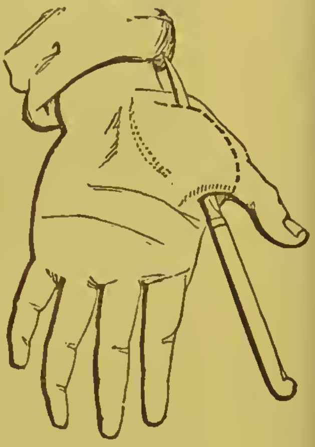


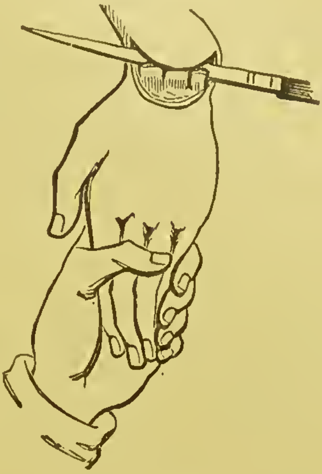
Fig. 546.



Amputation of the Little Finger, at its Carpo-metacarpal Articulation, may be performed in a similar manner.

Amputation at the Wrist-joint.—The radio-carpal articulation is as easily opened as any of the joints in the hand. An assistant holding the forearm, the operator lays hold of the hand on its palmar aspect, with his forefinger and thumb on the styloid processes of the radius and ulna; thus spanning the wrist, as the limits of the incision. A short narrow-bladed amputating knife is used instead of a bistoury, and an incision made from one styloid process to the other, across the back of the joint, slightly curving towards the hand. (Fig. 547.) Passing the knife across the joint, clear of the arched-shaped surface of the carpal bones, the lateral ligaments are divided, and the knife carried forward on the palmar surface of the metacarpal bones, so as to make a rounded flap of sufficient length to cover the ends of the radius and ulna, and unite with the dorsal incision. In turning the knife round the joint, care must be taken not to hitch against the pisiform bone, which projects forward on the palmar aspect, beyond the other bones of the carpus. The radial and ulnar arteries will require ligature or torsion, and perhaps some interosseous carpal branch.

Fig. 547.



This amputation, not often requisite, is intended to preserve the movements of pronation and supination. Inappropriate, therefore, for disease of the wrist, where the lower radio-ulnar articulation is involved, the operation is suitable for injury where no portion of the hand can be saved, but with sufficient sound integument to form the palmar flap.

An *artificial hand* may eventually be adapted to the stump; one of the most useful forms is here represented (Fig. 548), and one of its most important uses. (Fig. 549.)

Fig. 548.

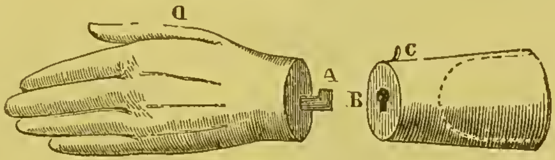
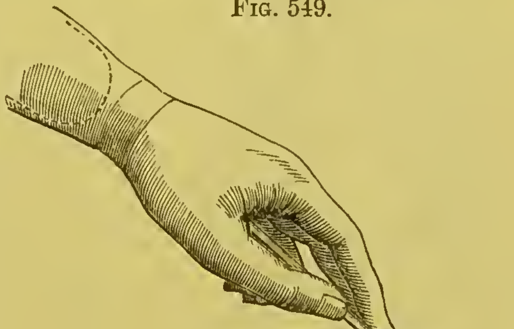
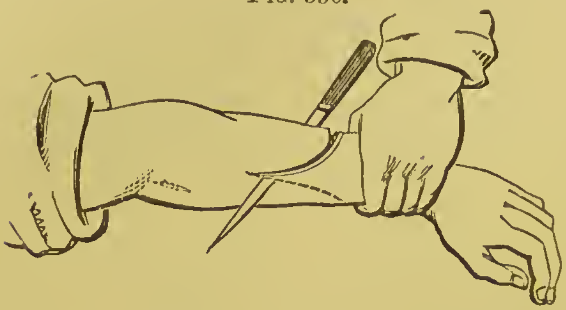


Fig. 549.



Amputation of the Fore-arm.—The middle of the fore-arm is the part to be preferred for amputation, as affording the most convenient coverings to the stump, and a tolerably suitable length of stump for the application of an artificial hand. The brachial artery must be commanded by an assistant, and the forearm held by another assistant, in a state of extension and semi-pronation,—the radius looking upwards. The margins of the bones should be felt by the operator with one hand; a posterior flap is then made by a curved incision downwards; commencing on the palmar margin of the radius—on the left side—and continued a little way down along the bone, arching across the back of the forearm, and up along the ulna to a point on its palmar aspect opposite to the other horn of the incision, it thus extends forward sufficiently on either side for easy transfixion in front of the bones. (Fig. 550.) This flap is reflected by a stroke or two with the knife; and the point being entered at one horn of the incision, in front of the bones, and made to emerge at the other, an anterior flap of corresponding shape and length is formed, by carrying the knife from within outwards along the surface of the bones. Both flaps are retracted by an assistant. Sweeping the knife around the bones to divide any remaining muscular fibres, and cutting across the interosseous membrane with the point of the instrument, the bones are then sawn together. The radial, ulnar, and interosseous arteries in the anterior flap must be ligatured or twisted, and the flaps adjusted with sutures.

Fig. 550.



This method of performing amputation of the forearm provides for easy transfixion, and is the most dexterous; but in a similar position of the forearm—semi-pronation, both flaps may be made by transfixion.

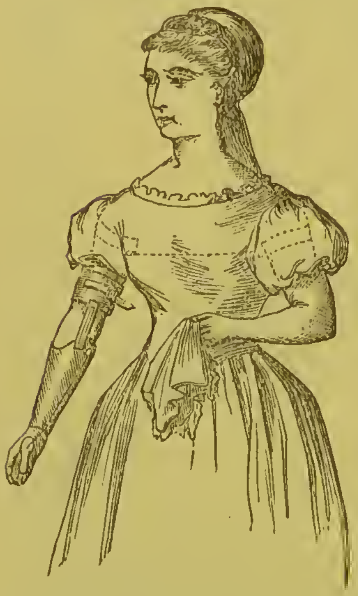
Amputation by a *long anterior*, and a *short posterior*, *rectangular* flap, on Teale's principle, will also form a good stump.

An artificial forearm may be fitted thus. (Fig. 551.) It is a modification, by Mr. Bigg, of Beaufort's arm. The hand may be adapted for a variety of important movements—as in writing or driving.

Amputation at the Elbow-joint may be performed by transfixion in front of the joint, just below the condyles, and forming a sufficiently long anterior rounded flap; then, dividing the lateral ligaments with a touch of the knife on either side, the joint is opened, and the blade being carried round the olecranon, dividing the attachment of the triceps tendon, a short semicircular skin-flap is formed posteriorly. The condyloid surface of the humerus should then be sawn off.

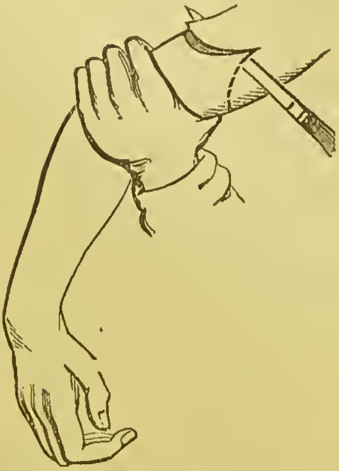
But this amputation is seldom eligible, or necessary. When removal of the limb is requisite for injury, there is seldom sufficient sound integument for the anterior flap; and in the case of injury or disease of the elbow-joint, excision may generally be performed.

Fig. 551.



Amputation of the Arm.—An assistant compressing the brachial artery, the Surgeon makes a couple of equal flaps, an anterior and a posterior; simply by transfixing the arm in front of the humerus, and cutting a well-rounded flap, and then entering the knife behind the bone and making another such flap. (Fig. 552.) These are retracted by an assistant. A sweep of the knife clears the bone, which is then sawn through; care having been taken that the musculo-spiral nerve was divided at the back of the bone—if the amputation be at that part of the arm where this nerve winds round behind the humerus. The artery and any bleeding branches of magnitude are secured, and the flaps brought together with sutures.

FIG. 552.



Circular amputation, as in the thigh, will be preferable, if the limb be very fleshy.

Amputation by a *long external*, and a *short internal*, *rectangular* flap, on Teale's principle, may be practised with advantage occasionally. This method is suitable where sufficient flaps cannot otherwise be obtained, more often from wasting or condensation of the muscles, in disease of the forearm.

Results.—Amputations of the forearm, or of the arm, are very successful. For disease, as of the joints or bones, amputation is especially successful; but far less so for malignant disease. For injury, the operation in either part is generally more fatal. The death-rate per cent. rises, as usual, relatively to amputation nearest the trunk. During the American War, the proportion was, after amputation of the forearm, 16·5; the arm, 21. In the

FIG. 553.

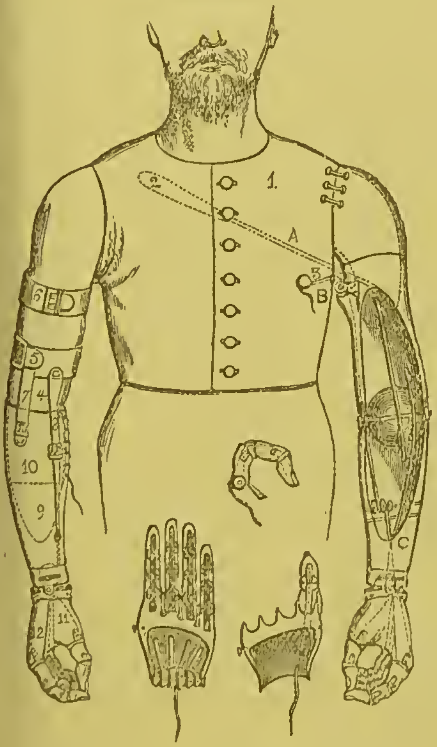
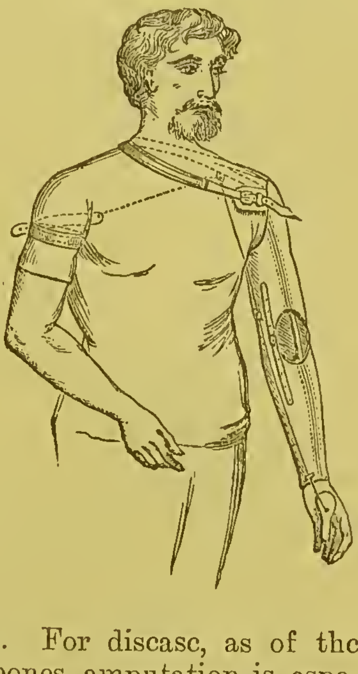


FIG. 554.



Crimea, amputations of the forearm were fatal in the ratio of only 7, and those of the arm 19, per cent. At Guy's Hospital, according to Mr. Bryant's statistical results, the ratio of fatal traumatic amputations of the forearm and arm was 16 and 22 per cent.; thus almost exactly equalling the proportionate mortality during the American War. And this comparative result was in *Civil* and *Military* practice respectively.

An *artificial arm* may be adapted to the stump; and of the various forms invented, the best construction is Van Petersen's, if the stump be long and mobile (Fig. 553); or the less costly arm invented by Count de Beaufort. (Fig. 554.)

AMPUTATION AT THE SHOULDER-JOINT.—An assistant standing above the shoulder, compresses the subclavian artery as it passes over the first rib; or, if he know the operation practically, he may be trusted to catch the artery with his thumbs in the inner flap. Another assistant holds the arm up so as to relax the deltoid muscle. The Surgeon—operating on the *left* arm—introduces a long-bladed amputating knife at the posterior border of the axilla, and passing it in front of the joint, makes it emerge at the anterior border of the deltoid muscle, about an inch below the point of the acromion; cutting downwards and outwards, a large flap is formed chiefly of the deltoid muscle and skin. (Fig. 555.) This flap is raised by an assistant at the shoulder, and the arm brought down towards the front of the chest; thus presenting the head of the humerus and muscles attached to the tuberosity. Running the knife across the joint, these are divided, with the capsular ligament, and the knife turned to the inner side of the joint, followed by the hand of another assistant ready to compress the artery. The arm is again raised to give freedom in making the flap, and the knife carried downwards close to the bone, forming an inner flap corresponding to the outer one; while at this moment the assistant in charge grasps the whole thickness of the inner flap with both hands, between his fingers and thumbs crosswise (Fig. 556), and catches the artery as it is divided. If this be done dexterously very little blood

FIG. 555.

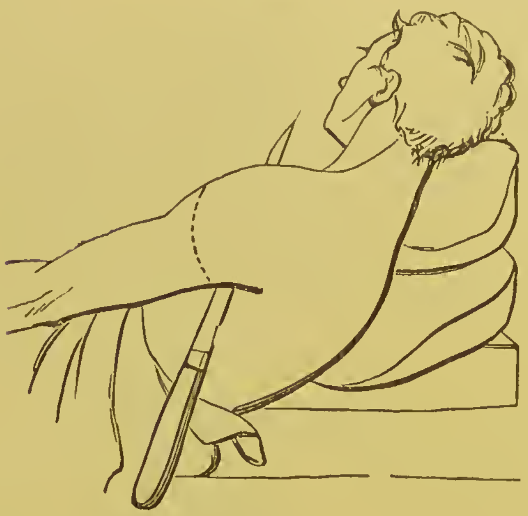
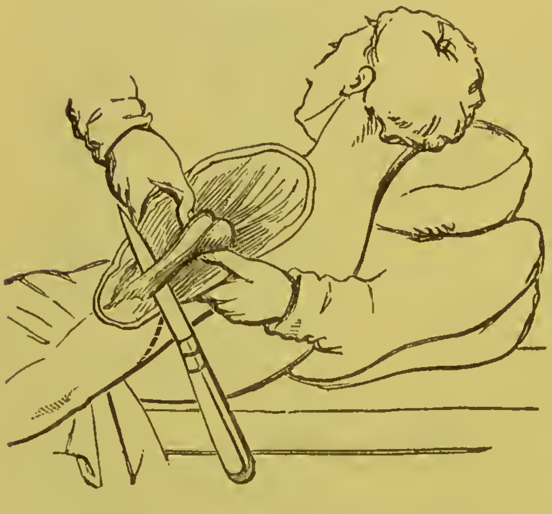


FIG. 556.



escapes. Amputation at the *right* shoulder-joint is performed in precisely the same way, only that the shoulder is transfixed from before backwards, the knife being entered in front of the deltoid about an inch below the acromion, and made to emerge at the posterior border of the axilla. The axillary artery and other vessels having been tied or securely twisted, the flaps are adjusted with sutures.

Spence's method consists, principally, in forming a large outer flap by incision. On the right side, for example; "the arm being slightly abducted, and the head of the humerus rotated outwards, an incision is made with a strong bistoury, on the inner aspect of the humerus immediately external to the coracoid process, and carried down through the clavicular fibres of the deltoid and pectoralis major muscles, to the humeral attachment of the latter muscle, which is there divided. Then, the incision is gently curved across and fairly through the lower fibres of the deltoid towards, but not through, the posterior border of the axilla. Unless the textures be much torn, the line of the lower part of the inner section is then marked by carrying an incision through the skin and fat only, from the terminal point of the vertical incision, across the inner side of the arm to meet the incision at the outer side. This insures accuracy in the line of union, but is not essential. The large outer flap is dissected up, and the head of the humerus disarticulated, as in the other mode of amputation. If the shoulder be very muscular, redundancy of flap is avoided by raising the integument only, from the deltoid, at the lower part, and then dividing the muscular texture higher up." Hæmorrhage having been arrested, and the flap adjusted by a few points of suture, a flat pad of lint is applied and secured by a six-tailed split cloth, the tails being fastened on the opposite side of the body.

Three advantages are claimed for this method of amputation at the shoulder-joint: the fullness and better form of the stump, instead of the ugly hollow which results from the opposed action of the pectoralis major in front, and the latissimus dorsi and teres major muscles behind; the preservation of the trunk of the posterior circumflex artery; and the greater facility offered for disarticulation.

Or, the outer flap may be made by incision from without inwards, and raising the flap upwards by two or three sweeps with the knife; a modification more suitable in amputation for *disease* of the arm, where the muscular texture has undergone atrophy or condensation.

Results.—Amputation at the shoulder-joint for disease of the humerus is more successful than the same operation for injury. The mortality in the one case was 1 in 4; in the other, 5 in 18 (Spence); and amounted to 35 per cent. during the Crimean War. The death-rate per cent. in the American War was 39; that after amputation in the arm being only 21 per cent., a difference of 18 adverse to amputation at the shoulder-joint. The injury requiring amputation, as compound fracture of the humerus high up, is usually accompanied with other injuries, particularly of the head, thus increasing the risk of a fatal result.

AMPUTATIONS OF THE LOWER EXTREMITY.

THE FOOT. (Figs. 557, 558.)—*Amputations of the Toes*, at their *Phalangeal Articulations*, and at their *Metatarso-phalangeal Articu-*

lations.—These operations are performed in a manner precisely similar to the analogous operations on the Fingers. In amputations at the last-named articulations, the incision must be commenced proportionately farther back than in the Hand, these articulations being situated at some distance above the web of the Toes; and it is undesirable to remove the head of the metatarsal bone, which would diminish the breadth and support of the foot.

FIG. 557.*

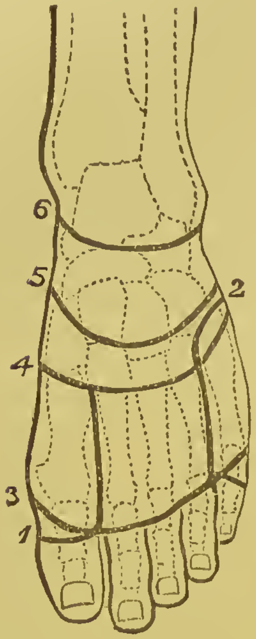
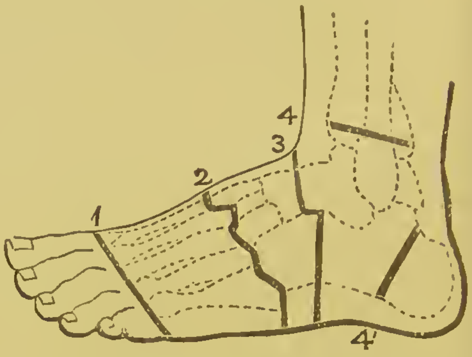
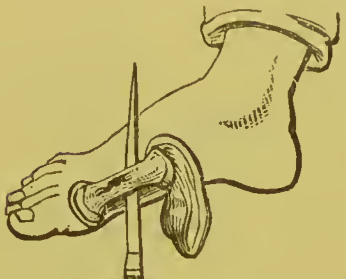


FIG. 558.†



Amputation of the Great Toe, at its Tarso-metatarsal Articulation.—With a stout bistoury, commence an incision on the dorsum of the foot, at the posterior extremity of the interspace between the metatarsal bones of the first and second toes; carry the incision forward to the ball of the great toe, and curve it inwards upon the ball to the sole of the foot, at a part opposite to the web between the toes; thence draw the knife backwards along the sole of the foot, parallel with the outer margin of the metatarsal bone of the great toe to a point opposite to the commencement of the dorsal incision. Dissect the flap back, close to the bone; divide the web between the first two toes, avoiding the sesamoid bone here situated, and isolate the metatarsal bone; then, twisting the great toe inwards, pass the knife deeply into the angle of the wound and open the articulation with the internal cuneiform bone, detaching its ligamentous connections —but avoiding the termination of the dorsal artery by directing the knife towards the joint, and thus complete the amputation. (Fig. 559.)

FIG. 559.



The *metatarsal bone alone* can be removed by the first part of this operation; the flap being made without then dividing the web of the toes.

Amputation of the Little Toe, at its Tarso-metatarsal Articulation.—

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* Diagram showing lines of incision from points of bone, in—1, amputation of great toe; 2, little toe; 3, all the toes; 4, or at their tarso-metatarsal articulations; 5, through the tarsus, or medio-tarsal; 6, at ankle-joint.

† Diagram showing lines of disarticulation, or section of bone, in—1, amputation of all the toes; 2, at their tarso-metatarsal articulations; 3, through the tarsus, or medio-tarsal; 4, at the ankle-joint; and 4′, with tuberosity of the os calcis.

This operation is analogous to that for the removal of the great toe; but the line of incision is here *single.* The knife is entered just behind the prominent tubercle of the metatarsal bone of the little toe, and carried inwards and forwards in the oblique line of its articulation with the cuboid; thence into the fourth metatarsal interspace forward to the web of the toe, and around under the toe, back into the incision on the dorsum of the foot. The integument is dissected off, exposing the metatarsal bone, and the bone isolated; then, the toe being forcibly drawn outwards, the joint is opened in the angle of the wound, and the operation completed.

Amputation of all the Toes, at their Metatarso-phalangeal Articulations.—This is accomplished by making a slightly curved skin-flap on the dorsal aspect, and a corresponding but larger plantar flap. In disarticulation the line of the joint offers no difficulty. Torsion will arrest the hæmorrhage from the digital arteries.

Amputation of the whole of the Toes, at their Tarso-metatarsal Articulations.—Hey's Operation.—This amputation is performed by a dorsal incision, slightly curved downwards, and a plantar flap, the limits of which transversely are the tubercle of the metatarsal bone of the little toe and the base of the first or the tubercle of the scaphoid bone in preference; the flap extending forward sufficiently to cover the end of the tarsal after disarticulation of the metatarsal bones. The leg is placed with the foot downwards, and steadied by an assistant; the Surgeon grasping the fore-part of the foot and feeling with his finger and thumb the points of bone above mentioned, he makes a semilunar incision from the one to the other across the back of the foot, cutting down to the bone and reflecting this short flap of integument. (Fig. 560.) Passing the knife under the bases of the metatarsal bones from one horn of the incision to the other, and transfixing the foot, a longer flap is made from the sole, extending up to the roots of the toes. (Fig. 561, 2). The irregular line of articulations is then opened with the point of the knife, while the fore-part of the foot should be forcibly depressed to facilitate disarticulation. The plantar flap is adjusted with sutures, and a single cicatrix remains on the dorsal aspect of the stump. (Fig. 562.)

Fig. 560.

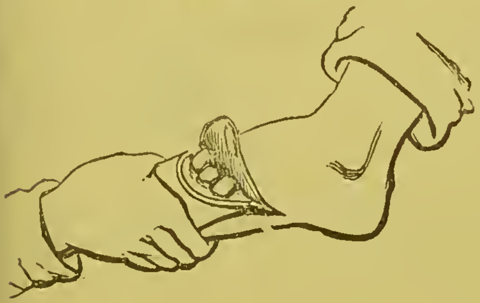
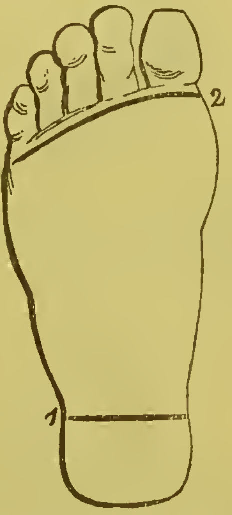
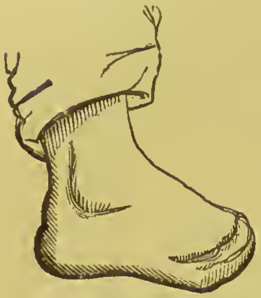


Fig. 561.



This amputation—by complete disarticulation—is, more correctly, *Lisfranc's* operation; Hey's *modification* consists in sawing off the projection of the internal cuneiform bone, and thus forming a more regular surface. The Surgeon should always endeavour to preserve as much of the foot as may be consistent with the removal of the diseased or injured portion beyond recovery, and the formation of sound covering; and among many illustrations of this principle I can give no better example than the useful foot remaining after I had removed all the toes between the great and little toe, at their tarsal articulations, in a case of crushing violence. (Fig. 563)

FIG. 562.



Amputation through the Tarsus—medio-tarsal— in the line of articulation between the astragalus and os calcis, posteriorly, and the scaphoid and cuboid bones, anteriorly.—*Chopart's Operation.*— The guides to this operation are the tubercle of the scaphoid bone on the inner side of the foot, and a point about half an inch behind the tubercle of the fifth metatarsal bone on the outer side of the foot, or about midway between this projection and the front of the outer malleolus. The operation is similar to Hey's, only that the incisions are commenced further back; the dorsal curved incision is made between the points of bone above named; the tarsal bones must then be disarticulated, and the plantar flap formed, keeping the knife well turned towards the under concave surface of the metatarsal bones, and extending this flap forwards to the root of the toes, where it should be rounded off across the sole of the foot. (Fig. 564.) The vessels are thus left uninjured, and an ample cushion formed. The head of the astralagus had better be sawn off; and the tendo-Achillis, which is apt to tilt this bone forward, may be divided by subcutaneous section at the time of the operation, or subsequently. The stump, as compared with that made by Hey's amputation, is here represented in section. (Fig. 565.)

FIG. 563.

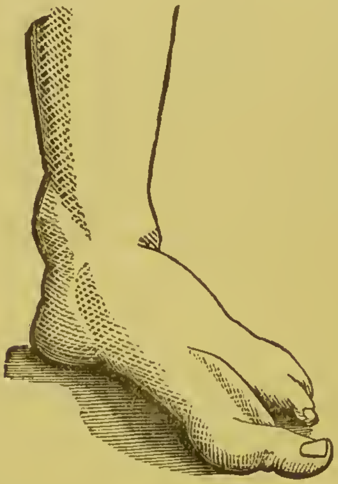


FIG. 564.

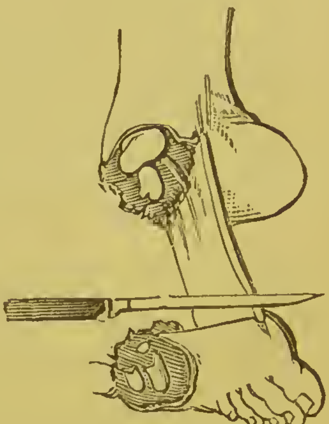
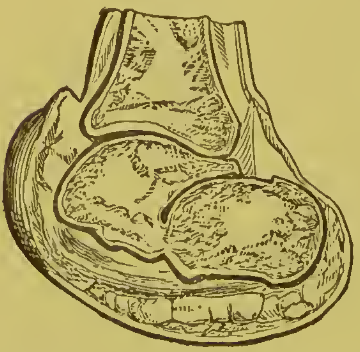


FIG. 565.*



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* Roy. Coll. Surg. Mus., 2817c. Stump after Chopart's amputation—medio-tarsal. Section. (Partridge.)

Amputation at the Ankle-joint.—*Syme's Operation.*—This amputation consists in making a posterior heel-flap, and an anterior incision across the joint; disarticulating the foot, and taking a slice off the end of the tibia. The foot projecting over the end of a table, and at a right angle to the leg, a stout bistoury is entered at the centre of one malleolus, and drawn downwards and slightly backwards, under the prominence of the heel (see Fig. 561,) upwards and forwards to a corresponding point at the other malleolus. (Fig. 566.) Or, the heel-incision may be carried slightly forwards. The flap, marked out by this incision, is dissected back to the tendo-Achillis; the operator placing his fingers upon the heel, while his thumb rests upon the edge of the flap, he cuts between the nail of the thumb and the tuberosity of the os calcis, pressing back steadily at the same time. In reflecting the integument round the tuberosity, the risk of making a button-hole will thus be avoided; and by still keeping the knife close to the bone on the inner side of the os calcis, the plantar arteries are not injured. (Fig. 567.) An incision is next made from one upper extremity of the heel-flap, across the dorsum of the foot, to the other extremity; then, depressing the foot, the joint is opened and the lateral ligaments divided by the point of the knife; the astragalus is disarticulated and the tendo-Achillis divided, as also any slight connection of the os calcis, and the foot removed. (Fig. 568.)

Fig. 566.

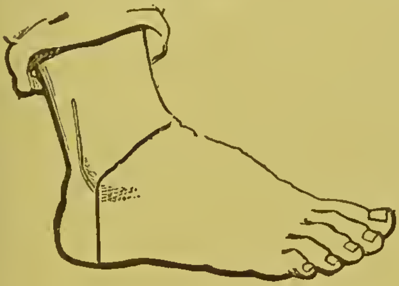


Fig. 567.

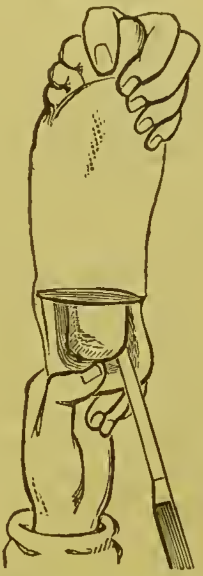


Fig. 568.

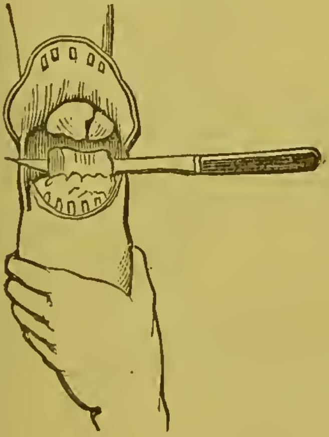
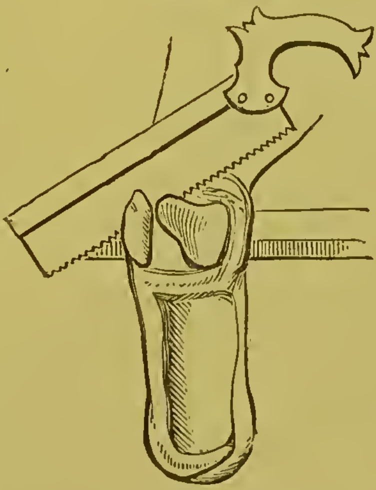
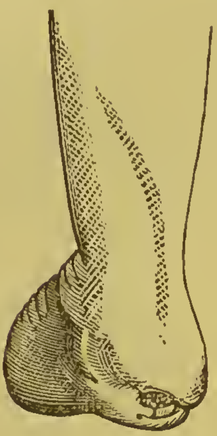


Fig. 569.



A thin slice is sawn off the end of the tibia, including the two malleoli. (Fig. 569.) The plantar arteries are secured, also the anterior tibial or dorsal artery of the foot, and the heel-flap is brought forward to the anterior incision and retained by sutures. To prevent dropping and bagging of the flap, with a tendency to sloughing, especially if the plantar arteries have been cut off short, a broad strip of adhesive strapping should be drawn over the end of the stump, from the back to the front of the leg. An excellent stump often results, with only a transverse line of cicatrix. (Fig. 570.) In this case, retraction of the heel occurred, from the action of the gastrocnemius and soleus muscles, producing an intractable ulcer in the most prominent part of the line of union; but this was remedied by tenotomy—division of the tendo-Achillis.

FIG. 570.*



Professor Pirrie makes a slight modification of this amputation, by sawing off the ends of the bones, *without* previous disarticulation of the foot; thereby shortening the operation.

Pirogoff's operation is a modification of Syme's. It consists in preserving the posterior portion of the os calcis, which is retained in the heel-flap. This flap is reflected back about two lines; the anterior incision is made, the astragalus disarticulated, and the malleoli sawn off with a thin slice of the tibia; then the saw is entered behind the astragalus on the upper and back part of the os calcis, which is sawn obliquely downwards and forwards. (Fig. 571.) The posterior portion of the calcaneum, thus left, is brought up into contact with the tibia (Fig. 572); leaving the tendo-Achillis undivided, and forming a longer stump for support. The osseous surfaces may readily unite. (Fig. 573.)

FIG. 571.

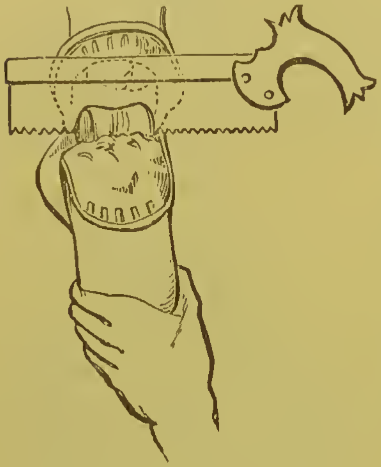


FIG. 572.

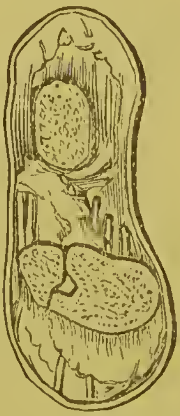
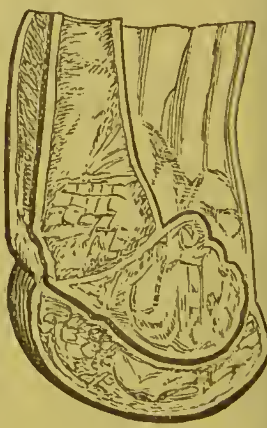


FIG. 573.†



The chief advantages of this operation are the increased length of stump, and the less liability to sloughing of the heel-flap—the plantar arteries always being cut long and the general vascular communications remaining undisturbed. The disadvantages are the greater liability to osteo-phlebitis, owing to the section of two osseous surfaces; and the recurrence of disease in the portion of calcaneum left in the heel-flap. This latter objection, however, does not apply to the amputation when performed for injury.

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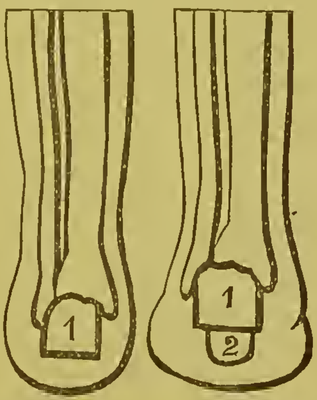
* Royal Free Hosp. Stump after Syme's amputation at ankle-joint. (Author.)

† Roy. Coll. Surg. Mus., 2817A. Stump after Pirogoff's amputation — ankle-joint and calcaneum. Section (Partridge.)

Professor Pirrie has devised a simplification of this operation also, and one which includes his modification of Syme's amputation. The os calcis is sawn from *below*,—upwards and backwards; and then—having made the anterior incision—the tibia and fibula are sawn through just above the malleoli, without previous disarticulation of the foot. But the downward section has always seemed to me more handy.

Amputation by a *large internal flap*.—According to the directions given by Professor Spence, the foot is held resting on its outer side. The knife is entered over the tendo-Achillis, and an incision carried obliquely across towards the outer and plantar aspect of the heel, then curving inwards across the sole of the foot, and upwards in front of the inner malleolus to a point beyond the tendon of the tibialis anticus muscle; thence the incision is continued over the dorsum of the foot, about an inch below the ankle-joint, and terminates at the point of commencement. The large flap is raised, avoiding the posterior tibial artery. Disarticulation at the ankle-joint is then effected, and a thin section of the tibia and fibula removed, just above the malleoli, as in Syme's amputation. The advantages of this modification, in the formation of the flap, are said to be the easy retention of the flap in position, by the tendency of its own weight, and the facility for discharge from the dependent angle of the wound.

FIG. 574.*



Sub-astragaloid Amputation.—Removal of the foot below the astragalus is analogous to Syme's amputation; that bone being left and the operation performed between it and the calcaneum, at the articulation of these bones. A heel-flap having been made, as in Syme's amputation, an anterior incision lays open the articulation between the astragalus and scaphoid bone, as in Chopart's amputation; the knife is then passed backward between the astragalus and calcaneum, dividing the interosseous and other ligamentous connections, and the foot is removed. A longer, and so far more useful, stump (Fig. 574) remains than after Syme's amputation at the ankle-joint; but sub-astragaloid amputation is comparatively rarely eligible,—only when the astragalus is not involved.

Hancock's Operation consists in amputation of the feet below the astragalus, leaving the posterior third of the os calcis, which is turned up against the under surface of the astragalus (Fig. 574), prepared for its adaptation and union therewith by also removing the under surface and head of this bone. This operation, therefore, bears the same relation to sub-astragaloid amputation, that Pirogoff's operation does to Syme's amputation at the ankle-joint. As an improvement on sub-astragaloid amputation, Hancock's amputation provides a more advantageous stump, in two essential points; namely, the length of the limb, and the amount of leverage afforded by the astragalus for the artificial foot, and the consequent effects upon the movements of the ankle-joint. This operation would seem to be suitable for disease or injury involving the tarsal bones, excepting the astragalus, and when limited to the anterior portion of the os calcis. It was originally performed by Mr. Hancock in the winter of 1864–65, and in the only case, so far as I know, in this or any other country; the case was one of scrofulous disease, which presented the requisite conditions for this amputation. The result was perfectly successful; complete union taking place between the section of the os calcis and astragalus, and the patient having a most useful stump. He was exhibited at the Royal College of Surgeons, in June, 1866, one year and a half after the operation; when, among many other observers, I had the opportunity of examining the permanency of this result.

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* Diagram of stump after sub-astragaloid amputation—1, astragalus.
Hancock's modification of this amputation—1, astragalus; 2, upturned portion of os calcis.

The particulars, therefore, of the original operation possess some historical interest; and as illustrating the plan and performance of an amputation not hitherto described in Surgical works, I shall here introduce Mr. Hancock's description:—"I commenced an incision beneath and at the posterior angle of the external malleolus, and carried it forwards along the outer border of the foot to a point about half an inch anterior to the projecting base of the fifth metatarsal bone. I then made a second incision along the inner border of the foot, commencing posteriorly about the centre and beneath the internal malleolus, and terminating anteriorly at a spot corresponding to the termination of the external incision; and then united the two by a third and semilunar incision, carried with its convexity directed towards the toes, across the front of the sole of the foot well down to the bones. Reflecting this flap back as far as the projections on the under surface, and in front of the tuberosity of the os calcis, I carried a fourth incision across the dorsum of the foot, immediately behind the head of the astragalus. Then, applying a saw upon the under surface of the os calcis as far back as I could, I cut through the bone obliquely from below upwards and backwards. Next, resuming the knife, I entered the medio-tarsal articulation, and, passing the instrument under the head of the astragalus, and cutting from before backwards, in the direction of the anterior articulating surface on the os calcis, divided the interosseous ligament, and detached the front of the foot. I then sawed off the head of the astragalus, and with a pair of bone-cutters, curved on the flat, removed the two articular cartilages on the under surface of this bone, and securing the two plantar arteries, thus completed the operation. The flaps were brought together by three wire sutures in front, the lower angles of the wound being left open. No suppuration ensued in the course of the tendons, no secondary hæmorrhage, nor any constitutional disturbance."

Results.—Amputation at the ankle-joint admits of the usual comparison as performed for disease or injury. Thus, for disease, in seventy-six cases, the mortality was only five; whereas, for injury, in six cases, one death ensued. Respecting the comparative mortality of Syme's and Pirogoff's methods of amputation, and the results of sub-astragaloid amputation, see EXCISIONS.

After any of these amputations at or immediately below the ankle-joint, an *artificial foot* may be adapted. A common and cheap form is a leathern hood, not unlike an elephant's foot (Fig. 575); or Bigg's artificial foot will be a complete apparatus. (Fig. 576.)

FIG. 575.

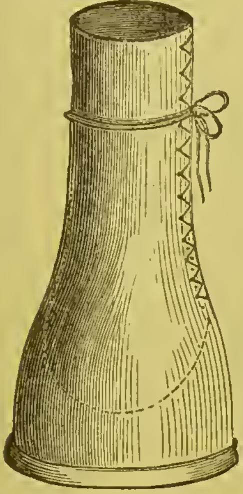
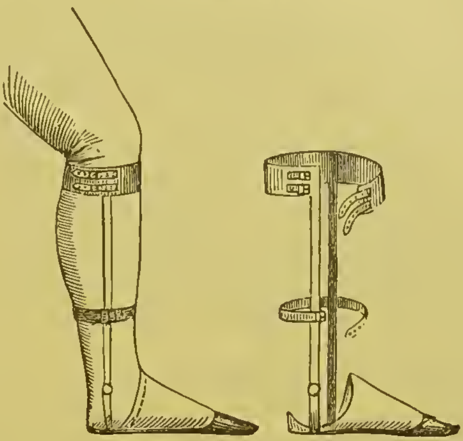
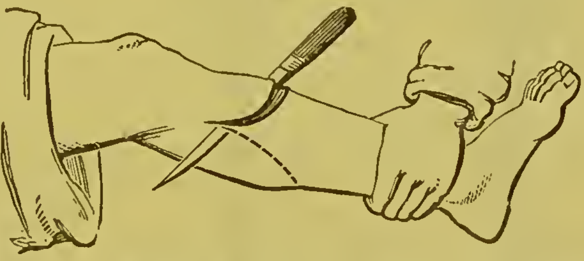


FIG. 576.



AMPUTATION OF THE LEG.—An assistant commands the femoral artery by digital pressure or compression with a tourniquet, and the leg, projecting beyond the edge of a table, should be held horizontally by another assistant seated on a low chair or stool. The Surgeon, standing as usual so as to grasp the limb below the seat of amputation, enters the point of the knife at the posterior edge of the tibia—on the left leg—carries it downwards on the bone for about an inch and a half, curves the incision across the anterior aspect of the leg to the posterior margin of the fibula, and up that bone to the point opposite its commencement on the tibial side. (Fig. 577.) The flap is reflected by a few touches with the point of the knife, which is then made to transfix the limb behind the bones from one horn of the anterior flap to the other—care being taken not to lock the instrument between the bones—and by cutting obliquely downwards and backwards, a long posterior flap is formed. The interosseous membrane is divided transversely, with the point of the knife, and a sweep round the bones clears a line for the saw. In applying the saw, the fibula should be divided first; otherwise, as a slender long bone, it will be splintered; and the tibia had better be sawn obliquely from before backwards, to make the anterior flap lay more easily than it would on the sharp ridge of a transverse section of the bone. Any projecting spiculous portion of bone must be clipped off with cutting-

FIG. 577.



pliers. The arteries requiring ligature or torsion vary with the situation of the amputation; in the middle third of the leg, the anterior and posterior tibials between the bones of the stump must be tied; in the upper third just below the knee, the popliteal trunk may not have bifurcated, and one artery alone may have to be ligatured.

Another mode of performing this amputation is by transfixion and the formation of a posterior flap first, and then the anterior semilunar flap.

The stump, in either case, is apt to bag and drop, owing to the bulk and weight of the posterior flap; which is not less than three inches in length, and bulky in proportion to the muscular development of the calf.

Teale's Amputation, by a long anterior and a short posterior rectangular flap.—This operation obviates the difficulty last referred to; but its comparative merits in other respects, as a mode of amputation, have been already considered.

Artificial legs are here represented; the common form, a wooden or "box-leg" (Fig. 578); the more complete leg (Fig. 579).

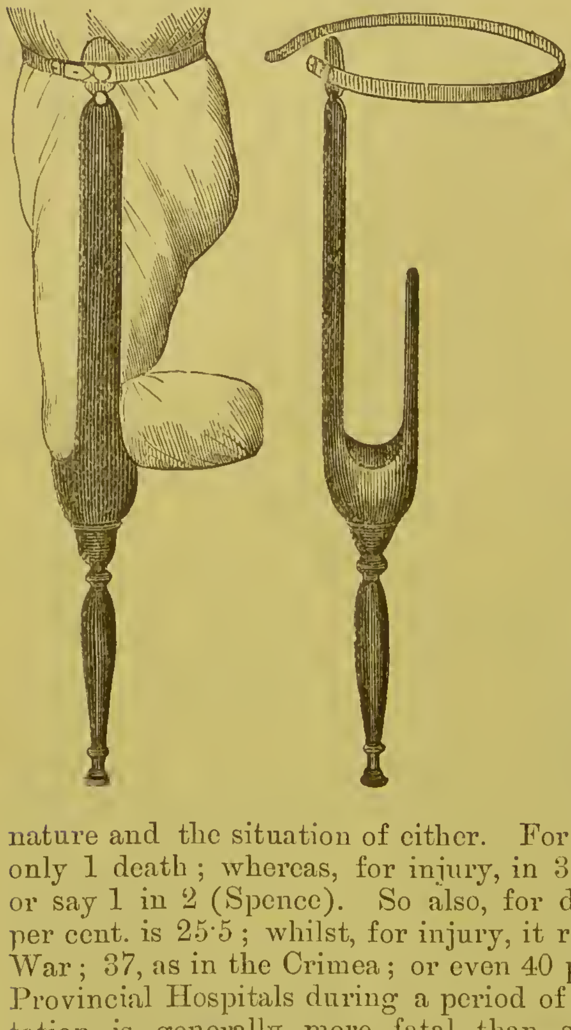


FIG. 578.

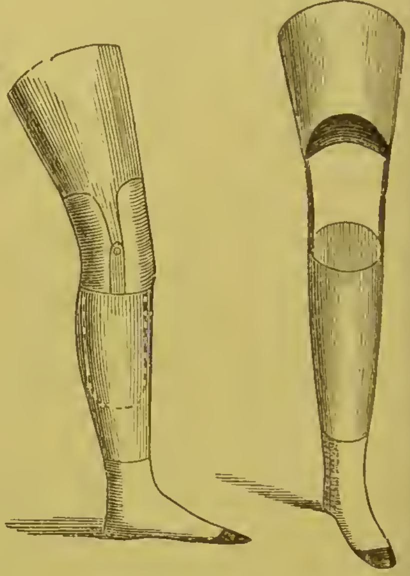


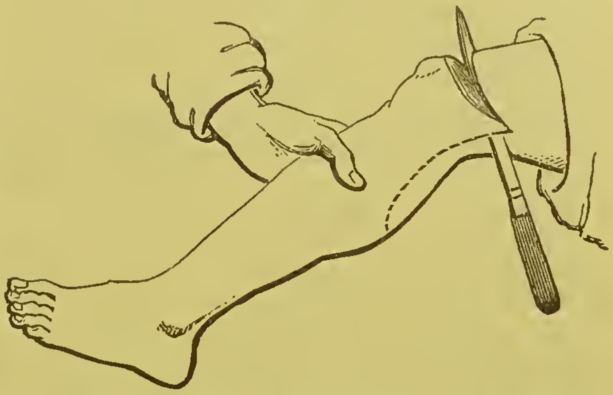
FIG. 579.

Results.—Amputation of the leg is, on the whole, a successful operation; but, like other amputations, the mortality differs according to whether the operation be performed for disease or injury, and the nature and the situation of either. For disease, in 22 cases, there was only 1 death; whereas, for injury, in 31 cases, there were 15 deaths, or say 1 in 2 (Spence). So also, for disease, the average death-rate per cent. is 25·5; whilst, for injury, it rises to 26, as in the American War; 37, as in the Crimea; or even 40 per cent., as in the London and Provincial Hospitals during a period of three years. Primary amputation is generally more fatal than secondary; but Mr. Bryant's statistics of cases in Guy's Hospital seem to reverse this rule; at the one period of operation the mortality being 62 per cent., and at the other or secondary period amounting to 66 per cent. Proximity to the knee-joint increases the risk of amputation.

Amputation at the Knee-joint.—Two methods of performing this operation are occasionally practised; by a short anterior and long posterior flap, or by a long anterior and short posterior flap.

Operation by a *short anterior and long posterior flap.*—A transverse or slightly curved incision is made across the knee-joint, above the patella, from condyle to condyle of the femur; the extensor tendon, lateral ligaments, and crucial ligaments are successively divided, and the joint fairly opened; the knife is inserted behind the tibia, a long posterior flap cut downwards and backwards from the upper part of the calf of the leg, and the leg removed. (Fig. 580.) The articular surface of the femur is then sawn off, the popliteal artery tied or twisted securely, and the flaps brought together with sutures. The stump made by this amputation may be most excellent, and as a permanent result. It was so in a case, after this mode of operation, by Sir W. Fergusson, in 1845. Since that time, the man has repeatedly walked forty miles a day, with a very indifferently made artificial leg; and on one occasion, a hundred and twenty miles in three days, without the slightest damage to the stump.

Fig. 580.



Operation by a *long anterior and short posterior flap.*—An incision is made from the lower margin of one condyle to the other, extending below the patella to a length of five inches across the tibia. The ligamentum patellæ must then be divided, and the flap of integument, including the patella, reflected; the lateral and crucial ligaments having been divided, the knife is passed behind the tibia, and a short abrupt flap cut outwards. The operation is then completed as before. The patella had better be left, for protection of the stump; but the cartilaginous surface of the condyles may be advantageously sawn off. This *mode* of amputation at the knee-joint is now generally preferred to that by the short anterior flap.

Amputation at the knee-joint was originally advocated by Petit, Brasdor, and Houi, and revived by Velpeau in 1830, but subsequently it attracted little attention. In 1857 Mr. Samuel Lane successfully amputated at the knee-joint, and has since repeated the operation in several cases; Mr. George Pollock also has operated in eight cases, and I have performed this amputation on six occasions.

Supra-condyloid Amputation may be performed in like manner as the operation at the knee-joint, only the incisions are placed proportionately higher up. The cartilaginous surface of the patella may be removed, and the bone brought down into contact with the end of the femur.

This amputation above, or at least through, the condyles, seems to have been first performed by Mr. Syme, 1845; but it was brought more prominently into notice by Mr. Carden, in 1864; and Gritti introduced the additional section of the patella.

The *artificial leg* constructed by Blaise is specially suitable to the stump formed by amputation, whether at the knee-joint or supra-condyloid.

Certain conditions are relatively appropriate for these two amputations, which, from Mr. Pollock's analysis of ninety-three cases in this country and America, may be thus stated:—1st. If there be no disease of the knee-joint, but, from disease or accident, amputation of the leg be requisite, it may be performed at the joint, without interference with the articular surfaces of the femur or patella. 2nd. If there be disease of the joint, resulting in ulceration of the cartilages, amputation should be completed by removal of the condyles of the femur, and the articular surface of the patella, or the whole of that bone.

The advantages of both these amputations at or just above the knee-joint, as compared with removal of the limb higher up, are three. They relate to the results of operation, both in regard to the mortality and the kind of stump.

Results.—Of 49 cases of amputation at the knee-joint, collected by Dr. Markoe, 17 were fatal; being a mortality of 37 per cent., or about half the percentage, 64, of amputation in the thigh, during the American War. But in that war the death-rate was 55 per cent. after amputation at the knee-joint. Of the 93 cases in the series by Mr. Pollock, 48 were collected by special returns from the Metropolitan Hospitals, of which 13 were fatal; and the remaining 45 cases, all of which occurred in America, and were gathered by Dr. Brinton, of Philadelphia, gave an equal mortality—13. Thus, the total mortality in 93 cases was 26, or a death-rate of 27·97. In the series of 60 cases collected by Mr. James Lane, 21 were fatal, showing a death-rate of 35·0. As compared with amputation in the thigh, in a total of 1346 cases, 560 were fatal, or a death-rate of 41·60.

The results of supra-condyloid amputation, in relation to its mortality, have not yet been indicated by statistics sufficiently extensive. Of 31 cases of Carden's amputation through the condyles, only 5 were fatal. Like the operation at the joint, it may fairly be inferred that this operation also is far less fatal than amputation in the thigh, there being less shock, less liability to suppuration, less risk of necrosis, and of osteo-myelitis; the medullary canal of the femur not being opened, in the two former amputations. The results with regard to the *stump* are certainly very advantageous; a long stump is provided for the adaptation, and more convenient use, of an artificial limb; and after the operation with a long anterior flap, the end of the stump is well covered by integument, and thus protected from the risk of excoriation from pressure, as the cicatrix lies altogether behind the surface.

Amputation of the Thigh.—An assistant compresses the femoral artery, and another, sitting on a stool, holds the leg so that the thigh shall be horizontal, and project from the buttock over the edge of a table. The Surgeon with his left hand lays hold of the fleshy part of the thigh in front of the bone, and raises it a little; then, introducing a long-bladed amputating knife just in front of the femur and transfixing the thigh, an anterior flap is made by cutting downwards and outwards to the surface. (Fig. 581.) Entering the knife again, about an inch lower than the upper limit of the former incision, and passing it behind the bone to the same point on the other side of the thigh, a posterior flap is made of corresponding length and shape. The advantage of re-entering the knife as directed, is not to jag the integument by the alteration of level necessary to transfix the thigh, in lowering it under the bone. Both flaps should be now retracted by an assistant, the knife swept round the bone at the highest point, and the bone sawn transversely across by a light vertical action of the saw. (Fig. 582.) The leg assistant must observe to evenly support the limb, as the bone is divided; not to lock the saw by elevating the limb, nor to snap and splinter the bone by allowing the limb to drop. The artery and any muscular branches must then be seized with artery-forceps (Fig. 583), and secured by ligature; or by acupressure, or torsion; and the flaps evenly adjusted with sutures.

FIG. 581.

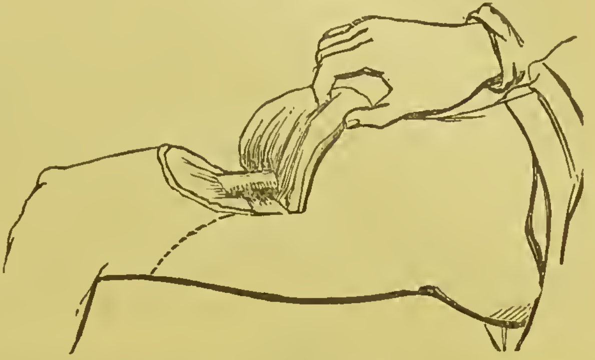
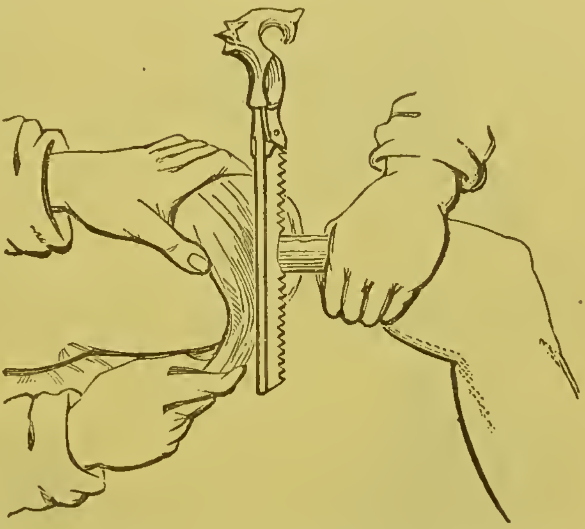


FIG. 582.

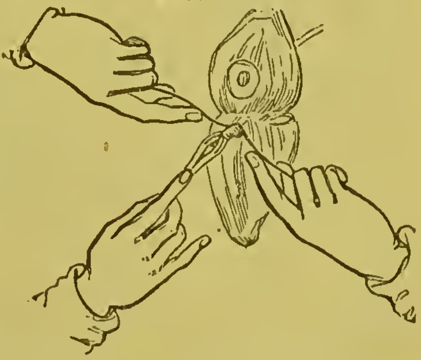


Liston's method of amputation by antero-posterior flaps consisted in the peculiarity of making the posterior flap longer than the anterior, so as to allow for the greater retraction of the flexor muscles, and thus balance the flaps.

Spence's method consists in the converse peculiarity of making the anterior flap the longer of the two; and the additional difference of transfixing the limb quite two inches below the line where the bone is to be sawn.

The flaps have a tendency to retract gradually to the point of transfixion; and thus, after Liston's operation, the greater retraction of the posterior flap will tend to draw the line of cicatrix towards the centre of the end of the stump, and thus make it correspond to the end of the bone; whereas, after Spence's operation, by the same

FIG. 583.



retraction, the longer anterior flap will fold over the end of bone, and the cicatrix becomes posterior to the centre of the stump. Moreover, the higher section of the bone insures a deeper covering, as the flaps cannot retract beyond the line of their bases.

The *circular mode* of amputation may be preferred, especially in a very muscular thigh (see p. 94).

Amputation of the Thigh, by Lateral Flaps.—Vermale's Operation.—In the lower third of the thigh, amputation is best performed by lateral, instead of antero-posterior flaps; the sides of the thigh, in this part, being more fleshy, and better fitted for the formation of a stump. The Surgeon grasping the soft parts, on the outer side of the thigh, with his left hand, and drawing them outwards from the side of the femur, the knife is entered perpendicularly in the middle of the thigh, about three inches above the upper border of the patella, and thrust downwards close round the bone, and brought out in the centre of the ham (Fig. 584); the flap then being cut downwards and outwards. The knife is again entered, at the upper angle of the incision, the thigh transfixed close to the side of the bone, and the point being brought out at the lower angle of the incision, a corresponding inner flap is made in like manner. Unless the blade be passed around the bone on this aspect of the thigh, the femoral artery is very apt to be split. The flaps are retracted, the bone cleared by a sweep of the knife, and the saw applied about four inches above the condyles.

FIG. 584.

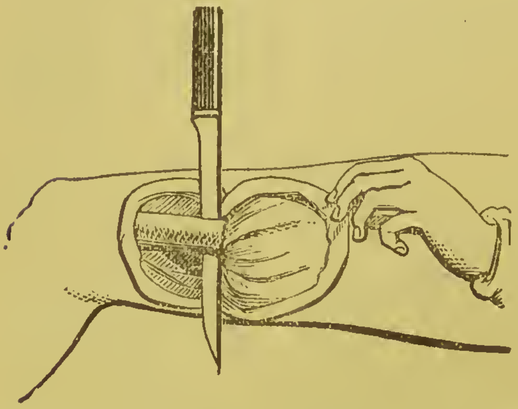


FIG. 585.

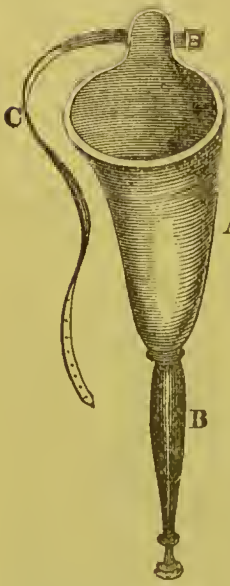
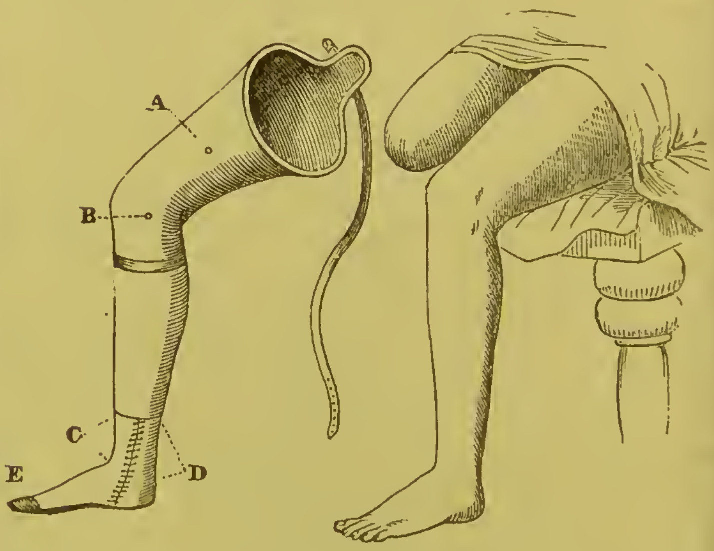


FIG. 586.



Forms of Artificial Leg.—(1.) *Bucket-leg* (Fig. 585)—A, a hollow sheath or bucket, accurately conformed to the shape of the thick stump; B, the pin for support; C, strap. The leg, as well as the one already noticed for amputation *below* the knee, is in common use by soldiers and sailors, or others of the working classes. (2.) *Bucket-leg*, with substitute *mechanism* for leg below the knee (Fig. 586)—A, bucket; B, knee-bolt; C, D, E, situation of springs, for mock muscles, governing the action of the ankle and toe joints. (3.) *Bly's leg*, of Rochester, New York (Fig. 587)—B, ball of polished ivory, for movements of ankle-joint; C, cords having the position and functions of the natural tendons; S, indicates three of the five india-rubber springs, as muscles; N, position of the nuts, for regulating tension of cords and springs; E, spring, acting on knee-joint. 2 represents ankle-joint flexed diagonally, as often occurs, when one side of the foot happens to rest on a stone or other obstacle in walking. (4.) *Bigg's leg*, a modification of Bly's and Mark's legs. (Fig. 588.) This is, perhaps, the simplest, strongest, lightest, and cheapest artificial leg or limb ever constructed. A gentleman, who had for years used limbs of other construction, wrote to Mr. Bigg, saying, "I never knew what comfort was with an artificial leg, until I adopted yours; it enabled me to walk to the Boat Race, and stand six hours about upon it."

Fig. 587.

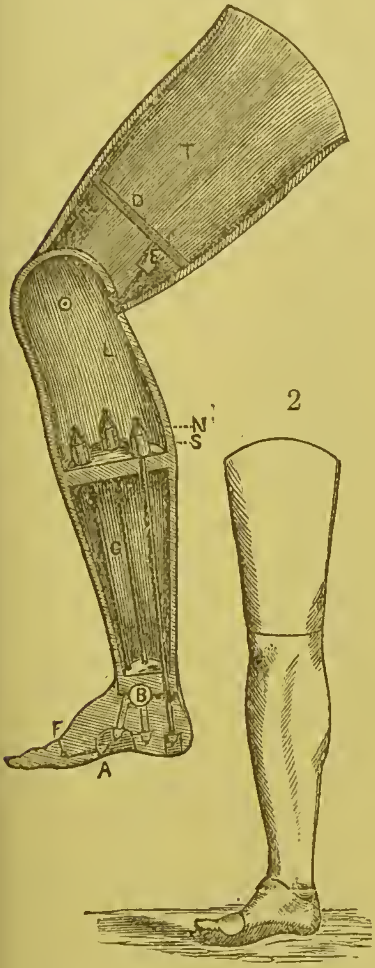
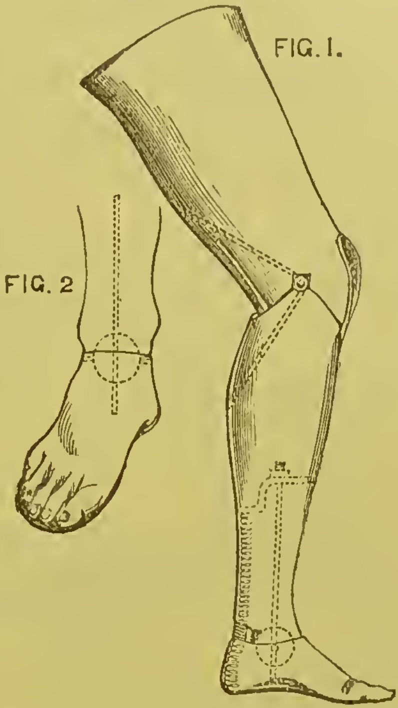


Fig. 588.



Other forms of artificial leg are the old Anglesea leg, as used by the Marquis of Anglesea, after the battle of Waterloo; the Palmer leg; and Mark's leg, an American invention.

Results.—Amputation of the thigh is more fatal than any such operation, except that at the Hip-joint; yet with a decided difference in favour of disease, as compared with injury. As performed for disease, in 106 cases, 26 were fatal, or say 1 in 4 cases; but, for injury, in 29 cases, 20 proved fatal, or say 2 in 3, or $\frac{2}{3}$ of the whole number (Spence). In the American War, the percentage of mortality was 64, after amputation for injury. But the period of the operation, as primary or secondary, makes some difference in the mortality, and in favour of primary amputation, unless when performed for compound fracture of the femur, instead of for injury to the knee-joint or the leg.

Amputation at the Hip-Joint.—This operation, so fatal in its results, is less formidable in its performance. The patient lying with his buttock on the edge of the table, an assistant supports and governs the limb; another assistant, standing at the pelvis on the side of operation, compresses the artery above the brim of the pelvis, and is ready to take charge of the vessel when divided in the first incision. Or, the risk of hæmorrhage may be guarded against by means of the aortic tourniquet invented (1860) by Professor Pancoast, of Philadelphia, and which is sometimes erroneously named Lister's compressor of the abdominal aorta. (Fig. 589.) The Surgeon, standing as usual with his left hand towards the distal part of the limb, selects the longest-bladed amputating knife; introducing it—in the *left* limb—about midway between the anterior superior spinous process of the ilium and the great trochanter, he thrusts it directly across the joint, so that its point shall emerge just above the tuberosity of the ischium (Fig. 590), the scrotum being drawn away and protected by an assistant. The knife, thus transfixing the root of the thigh, is carried rapidly downwards and forwards to the surface, cutting an anterior and inner flap, about five or six inches in length, and the breadth of the thigh. The assistant, at the pelvis, closing his hands into the wound from either side, catches the femoral artery in the under surface of this flap, between his fingers beneath and thumbs over the flap. (Fig. 591.) The limb should now be forcibly abducted and everted by the leg assistant; the capsule

Fig. 589.

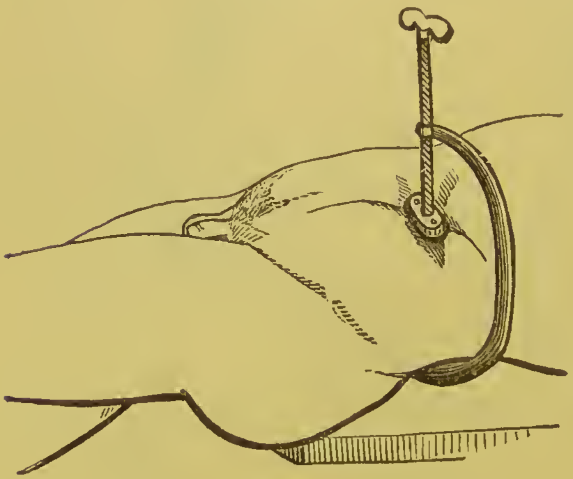
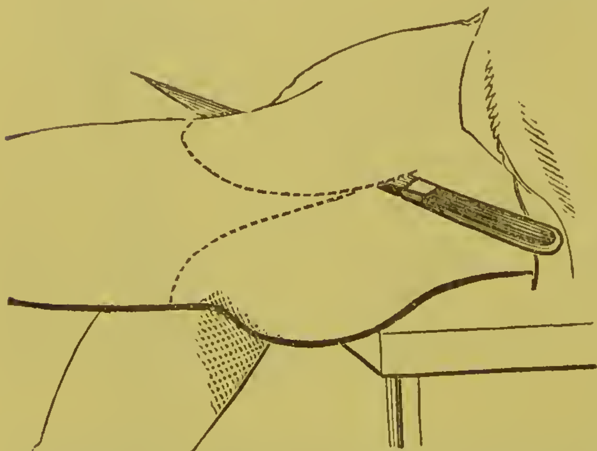
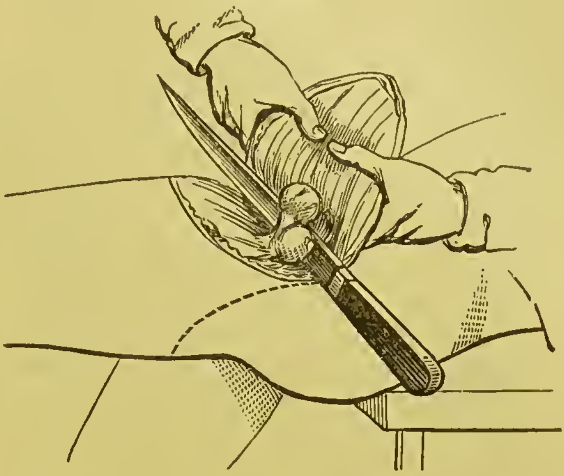


Fig. 590.



opened from the inner side by drawing the knife firmly across, when, with a touch on the round ligament, the assistant depressing the limb, the bone starts from its socket. The blade is then laid on, about its middle, behind the head of the femur, the remainder of the capsule divided, and by drawing the knife downwards and backwards through the muscles, a shorter posterior flap is fashioned to meet the anterior one. The artery and any muscular branches having been secured, and the large cavity well sponged with cold water, the two flaps are brought together with sutures, and a large compress applied. On the *right* limb, the operation is the same, only that the knife is *entered* in the reverse directions; namely, just above the tuberosity of the ischium. (Fig. 592.)

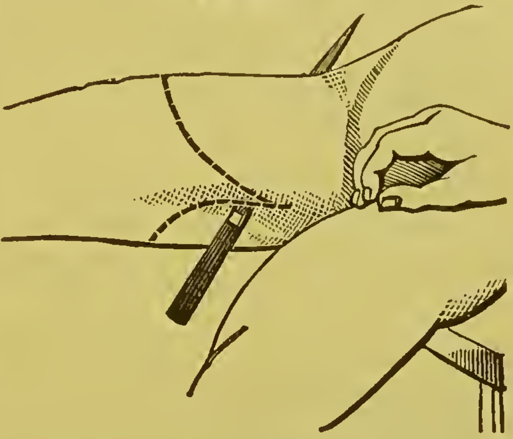
FIG. 591.



This method of amputation at the hip-joint, by anterior and posterior flaps, is substantially the same as that recommended by Liston.

By the same mode of operation, also, the femur can be sawn through *below the trochanters*, in fracture of the shaft high up, or disease affecting the shaft below; thus leaving the head and neck of the bone, with ample flaps to cover. I have amputated just below the hip-joint for disease of the femur, consequent on typhoid fever, and with an excellent stump resulting.

FIG. 592.*



The above-described amputation will have to be modified by various conditions of injury necessitating the operation, but which require its adaptation to the state of the integuments, as affected by the extent of contusion and the situation of wounds. The flaps must be contrived so as to meet these difficulties.

In a case of "severe compound comminuted fracture of the right femur," for which I had to perform amputation at the hip-joint, the operation was modified by the state of the integuments. The particulars of this operation were well reported, in the "British Medical Journal," by Mr. C. S. Jeafferson, then senior house surgeon to the Hospital. The margin of the wounded integuments was obliged to be taken as the line of incision, otherwise no skin could have been obtained to cover the stump, and a kind of oval amputation was performed as follows:—Entering the knife just below the middle of Poupart's ligament, it was then drawn obliquely downwards and inwards, crossing the back of the thigh, and prolonged upwards and inwards to the point of its departure; in this way an oval flap was made from the integuments of the back of the thigh and buttock. The muscles were then divided, the femoral artery secured, and the head of the femur turned out of the socket. Although little hæmorrhage resulted from the operation, the patient towards its end showed symptoms of severe collapse. On being placed in bed, he recovered from chloroform, but expired within three hours of the operation.

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* The knife is represented as transfixing the thigh in the posterior, instead of the anterior, line of flap.

Results.—Amputation at the hip-joint is an operation of fatal result in the great majority of cases; in 126 cases, 76 having died. But the mortality differs considerably according to whether the operation be performed for disease or injury. Thus, in 9 cases by Mr. Spence, of 4 for disease, 2 died; but of the 5 for injury, 4 died. In 42 hip-joint amputations for chronic disease of the femur, 18 died; whereas, in 47 for injury, 35 were fatal; and the death-rate percentage was 85 during the American War. Primary amputation for injury is the most fatal; in 30 cases, collected by Legouest, all died; and in another 12, during the Crimean War, all died. In the American War, however, of 19 cases, 2 recovered. Secondary amputation for severe injury to the femur has been far more successful; of 9 cases in America, 2 recovered; and in 4 cases, by J. Roux, during the French campaign of 1859 in Italy, all recovered. Re-amputation at the hip-joint, for diseased thigh-stumps, has proved successful in 4 out of 7 American cases.

CHAPTER XLI.*

DISEASES OF THE SKIN.

The skin illustrates in a pre-eminent degree the pathology of the body in general. It is liable to disturbances of circulation, of innervation, and of nutrition, and to aberrations of its secreting functions. Disturbance of circulation may present itself as simple excess of blood in the blood-vessels, that is, hyperæmia or congestion, or it may be accompanied with consecutive phenomena, and constitute inflammation. Disturbance of innervation may be evinced by excess of sensibility and pain, or by absence of sensation more or less complete. Disorder of nutrition may present itself as simple excess of growth or hypertrophy, as arrest of growth or atrophy, or in the form of perverted growth. Finally, the secretions may be altered and impaired, changed in quantity and likewise in quality.

Hyperæmia, or congestion of the skin, is a state of simple distension of its vessels with blood, and, according to the nature of the cause, may be active or passive, acute or chronic. Acute hyperæmia is marked by its brightness of colour and speedy disappearance; chronic hyperæmia, by its crimson and purple hue, and by its permanence—in other words, by the rapid flow of arterial blood through the dilated vessels, in the one case; or by the slower current, which gives time, through its sluggishness, for the venous change of its colour—in the other.

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* By Professor Erasmus Wilson, F.R.C.S., F.R.S.

Hyperæmia is the essence of that congested state of the blood-vessels of the skin, which is termed *erythema;* and erythema presents a similar series of forms: it may be acute and evanescent, or it may be more or less enduring. Erythema is a hyperæmia of the skin, but the term is rather subjective than objective, and relates to the appearance of the skin more than to its pathological condition. Erythema, however, advances a step beyond simple hyperæmia, and is capable of assuming certain consecutive changes which give it the character of an inflammation. One of the commonest forms of erythema is urticaria, or nettle-rash; there is redness, betokening congestion of the blood-vessels, and the redness rapidly subsides and in a few hours vanishes completely, leaving no trace of its existence behind, and reminding us of the operation of a blush, which may be intense for a brief period, but which disappears completely in a short space of time. There is a form of erythema which is identical in character with a blush, but the cause is different; it is pathological instead of being physiological, and, although slight in its nature, betokens an operation which is not simply emotional, like a blush, but obeys some deeper cause, implying disturbance of function.

The simplest idea which can be given of erythema is that of redness of the skin consequent upon a pathological cause, and in proportion to the power of that cause the redness will be transient or permanent, circumscribed or diffused, or even migratory. The redness may be accompanied with heat in a greater or less degree, with itching, and with swelling. As an illustration of an erythema of a transient nature, dependent on a trivial and temporary cause, let us take the so-called flushing after meals, excited by undue stimulation of the nerves of the stomach, operating by reflex action on the vaso-motor nerves of the face and head. The erythema being extra-physiological, must necessarily be pathological, and, when repeated day after day, will lay the foundation of a fixed and permanent erythema. In its evanescent form, this cutaneous hyperæmia has been termed *erythema fugax;* while its permanent character would constitute *chronic erythema.* In the above instance, the cause is simple and evident; but it is clear that a similar effect would be produced by a hidden cause; and then, for want of a better expression, we should call the affection *idiopathic erythema.*

A still more obvious illustration of erythema may be observed in the effects of a local cause—for example, undue friction and pressure, a form which has received the name of *intertrigo;* the action of heat, as in burn, and especially sunburn; and cold, as in the instance of chilblain; and of external irritants in general, such as mustard and cantharides, strong acids and alkalies, bites and stings of insects; together with cuts, scratches, punctures, and bruises. This group differs from the former only in the ratio of the directness or indirectness of the injury.

It is impossible to advance a step in the study of pathology without recognizing the mutual dependency and reaction of the three principal factors of disease, the nerves, the vessels, and the tissues; and although appearances have given the blood-vessels a prominent place in pathological operations, the vessels are but passive agents under the control of the nerves, and the tissues are subservient to both. Already we have seen that an irritated pneumogastric nerve stimulates morbidly the trifacial nerve; and, in the local examples already cited, the incident nerve equally transfers its irritation to a reflex nerve, although by a shorter curve. We shall, at a later period, have to consider that dependent independent life which belongs to the cell-elements of the tissues, and which, under the influence of hyperæmia, plays a not inconspicuous part.

But we have said enough to demonstrate that erythema may be *constitutional* or it may be *local;* it may be *transient* or *permanent;* it may be *fixed* or it may be *diffused*, and it may also be *migratory*. One of the most obvious of the phenomena of pathology is that of degree, and this is well illustrated by erythema. Erythema in its normal form presents redness, heat or itching, and slight swelling from simple turgescence of blood-vessels. But each of these symptoms is liable to modification. The redness may be bright, or dull, or purple, or almost black, according to the speed of circulation through the blood-vessels. For example, note the vividness of hue of scarlatina, which, so far as the skin is concerned, is an erythema; the deep crimson of roseola and rubeola, from which they derive their names; the lividity of a chilblain, the blueness of morbus cæruleus, and the deep tones of purple of congestion resulting from obstruction of the venous circulation. The heat may convey the sensation of a pleasant glow, or be an insufferable burning; the itching may be trifling or intense, as we see exemplified in urticaria; and the swelling may be scarcely perceptible, or it may give rise to prominences which one while resemble pimples, another while tubercles and even tumours or tumefactions of considerable size and extent.

These differences of character of erythema have suggested the terms *E. papulosum*, *E. tuberosum*, *E. nodosum*, and *E. tumescens*. Erythema papulosum and tuberosum are commonly met with around the joints, as a consequence of gastric irritation and rheumatism; erythema nodosum is usually seen on the lower extremities, and has gained its name from a resemblance in figure to a node of the shin; while erythema tumescens is generally single, and forms a massive swelling as large as the hemisphere of an orange or melon. It not unfrequently attacks the eyelids and face, and sometimes the interior of the mouth or the tongue. The tumescent form somewhat resembles urticaria in the suddenness of disappearance of the swelling; and the latter symptom, which is due to a temporary infiltration or exudation, reminds us of the widespread intumescence and infiltration of erysipelas.

Erythema is generally diffusive in a greater or less degree; sometimes it simply spreads in breadth, but more frequently it subsides in the centre whilst it spreads by the circumference, in this manner giving rise to circles or rings (*E. circinatum*) of various extent; the rings may be small, and confined to a limited region, or they may spread over the whole of the trunk of the body, intersecting each other in their course, and producing a confusion of curved figures, which have been called *E. gyratum*. One very interesting form of centrifugal erythema has received the name of *E. iris*, in consequence of its throwing out a succession of circular rings around its centre; the rings acquiring a difference of colour from age, and being likened to a rainbow. This kind of eruption is commonly met with on the extremities, and especially on the back of the hands.

Our review of erythema up to this point assumes to be founded on a healthy state of the blood-vessels and of their contents; but in a state of dyscrasia of the blood and of the capillaries, the blood is apt to escape into the intervascular spaces in the form of puncta or blotches, and to constitute purpura—the spots and blotches being variously named stigmata, petechiæ, vibices, and ecchymoses.

We have commenced our review of the pathology of the skin with the consideration of erythema, because it represents the slightest form of aberration from the standard of health, blending in its mildest degrees with simple physiological disturbance; although stretching onwards from that point to very grave forms of disease, such as inveterate urticaria and erysipelas. One of the most conspicuous symptoms of erysipelas is infiltration of serous fluid into the tissues of the skin, and the escape of that fluid beneath the epidermis, where it forms bullæ or blisters. This phenomenon has suggested the term *erysipelas bullosum*, and it calls our attention to another circumstance, namely, that such an effusion is more common in certain constitutions than it is in others.

The skin is liable to serous effusion beneath the epidermis from a base of simple erythema, often so slight that the bulla itself is the first evidence of cutaneous disorder; and this bullous effusion has received the name of pemphigus. Sometimes the bulla is solitary (*P. solitarius*), in which case it may assume the magnitude of a hen's egg; at other times it makes its appearance in clusters of irregular form and size, and with bullæ equally irregular in point of bulk. Other names which have been assigned to its different forms, such as "benignus" and "gangrænosus," demonstrate that, while in general the affection may be trivial, it may sometimes be attended with a state of atony nearly approaching to gangrene. As a rule it may be assumed that pemphigus implies debility of constitution and debility of tissue, and, where it exists extensively, is sometimes fatal. A spreading form which is apt to occur on the trunk of the body, and shows itself as a stratum of collapsed blisters resembling dried leaves (hence *P. foliaceus*), is apt to exert the baneful influence of an extensive burn, and be fatal in its operation; whilst another form, with smaller bullæ, is acompanied with intense pruritus, and is very serious. Occasionally, the centrifugal growth already referred to in connection with erythema is evinced as a pemphigus circinatus; and in a similar manner erythema iris, by the development of a blister in the centre, becomes converted into a pemphigus iris.

Hyperæmia of the skin, with an exhausted state of the cutaneous tissues, such as occurs in some fevers, particularly those accompanied with profuse sweating, where heat and moisture contribute to the result, sometimes gives rise to a diminutive form of pemphigus—an eruption, in fact, of small vesicles, which from their minuteness of size are called *miliaria*, and occasionally, from their association with sweating, *sudamina*.

Pemphigus and miliaria have been denominated bullous or vesiculous affections, and one of the forms of eczema has been included in the same group; together with another affection, *herpes*, which is marked by a vesicle intermediate in bulk between that of miliaria and pemphigus. Herpes is essentially a crop of vesicles developed on an erythematous base; but it possesses two additional features which render its separate consideration necessary. For example, unlike pemphigus and miliaria, it has a definite course; and secondly, it is associated with more decided neurotic phenomena, sometimes running on to neuralgia of a very painful character. This undisguised neurotic dependency of herpes has suggested its consideration as a neurosis, and as such it has been associated with urticaria—an erythematous neurosis. And it may be as well to mention that in a case of pure prurigo we have seen developed concurrently, at the height of its exacerbation, the tubercles of urticaria and the bullæ of pemphigus. Moreover, so close is the alliance between herpes and neurosis that its forms admit of being designated by the names of the nerves whose territories the eruption invades; for example, herpes zoster is termed *H. intercostalis*, and in like manner we have herpes cervicalis, cervico-humeralis, lumbo-cruralis, frontalis, maxillaris, occipitalis, and so on; while certain minor herpetes are named from their locality, although equally due to neurotic origin, *e.g.*, herpes labialis and herpes preputialis.

The commonest of all the affections of the skin is an inflammation of its entire structure, which evinces itself not merely by redness, heat, swelling, and pain, but by modifications of the typical symptoms due to the special nature of the organ itself; for example, redness, papulation, vesiculation, exudation, and desquamation, with certain secondary and consequent phenomena, such as suppuration, incrustation, thickening, and condensation. Such, indeed, is eczema. If the redness were to remain stationary at the hyperæmic stage, the rash would very properly be named erythema; but if it proceeded a step beyond, it is then an eczema, which may be distinguished by the superadded title of *erythematosum*. Eczema not unfrequently occurs as a sudden exanthema of the entire skin, and may then subside with simple exfoliation of the cuticle, like any other form of rash. If, however, the cause persist, the follicles may become congested and raised above the surrounding level in the shape of papulæ; this is *E. papulosum*. When the turgid vessels relieve themselves by effusion beneath the epidermis in vesicular papules in lieu of solid papules, the case is one of *E. vesiculosum;* or the exudation may be so excessive that the cuticle is lifted up from the cutis in a stratum of considerable extent, and the secretion, one while simply a plastic serum, and another while purulent, becomes converted into a profuse defluxion (*E. ichorosum*), perhaps soaking through all the coverings which surround it (*E. madidans*). In a moderately severe case of eczema, the whole of these forms will be present together: in the focus of the disease, there may be an aqueous and puriform exudation; farther outwards, vesicles serous and pustular, intermingled with papules rising from an erythematous base; while in the circumference the erythematous congestion will be found alone. At a later period of the disease, when the skin is returning to a healthy state, the secretions dry up into the form of crusts of divers thickness, colour, and texture; the swelling subsides; but for a long time an epidermic desquamation of small dry, horny scales continues, before the skin regains its normal condition.

Eczema implies not only an intense form of hyperæmia, but likewise a certain amount of serous transudation through the blood-vessels, causing swelling and thickening, often to a considerable degree. The quantity of transudation constitutes the difference between dry eczema and moist eczema; and this difference is quite irrespective of the disease, and merely relates to the more or less lymphatic or humid constitution of the individual. A large accumulation of fluid in the tissues, such as we frequently meet with in the lower extremities, and particularly where the venous circulation is languid or obstructed, not only gives rise to a humid eczema, but causes a passive nutrition of the connective tissue and a state of hypertrophy of the skin and subcutaneous substance which approaches in appearance to the elephant-leg of the Arabians, *E. hypertrophicum.* In a less degree, thickening and condensation of the integument after eczema is a common sequela, and in these cases the hypertrophic tendency is evinced by a copious formation of epidermic scales, or by an indurated wart-like surface.

The most conspicuous of the subjective symptoms of eczema are burning heat and pruritus, the pruritus being often of the intensest possible description. This symptom was expressed by the Fathers of Medicine by the word "psora," which is the Greek designation of eczema; while its dry chronic squamous and pruriginous sequela was denominated "psoriasis." It is worthy of remark that the dry forms of eczema are often more intensely pruriginous than the moist forms; so are the moist forms in their dry stage, and severe scratching of the surface, or other means which induce exudation, is the most efficient mode of relief. As a simple inflammation of the skin infinitely variable in degree, eczema is found to attack every region of the body, and to present a corresponding variety in extent; but it is incapable of breaking through the bounds which are allotted to it by the regular pathology of the skin. It may present few or many of its pathognomonic symptoms, in greater or less degree, but there are none which we are not thoroughly prepared to expect, and which are necessarily included in the operations of inflammation; and sometimes, especially in chronic cases, manifestations are evinced of a decidedly neurotic character.

We have already seen that the special signs of eczema may and do occasionally make their appearance in an independent form. Thus, a fixed eczematous hyperæmia of the skin might easily be set down for an erythema until the concurrent symptoms are investigated; so also a crop of papulæ might be regarded as a *lichen;* and there is one vesiculo-pustulous affection in particular which is more nearly allied with eczema than with any other pathological form of dermatosis, namely, *impetigo.* Impetigo is a vesico-pustule developed on an erythematous base, sometimes in patches and sometimes scattered over the surface of the body. It is peculiar to a delicate skin, and especially that of children, and is apt to give rise to crusts around the mouth, which might easily be mistaken for eczema but for the absence of eczema on other regions of the frame.

The idiosyncrasies of the skin evinced under the influence of a local irritant are curiously exhibited in the instance of the acarus scabiei. In a lymphatic and sanguineous temperament, as in children, an exudation will appear in the form of vesicles and ichorous excoriations; while in the adult, and in a dry and nervous temperament the manifestation will be erythema and dry pimples. Or it might be that while vesicles, vesico-pustules, and excoriations may be present together on the hands, the lesion on the rest of the body will be one of papules only. The cause is identical in each instance; the difference of lesion is traceable to the constitution of the individual. And the same may be said of eczema and its causes—one while a dry, and another while a moist eruption; one while simply ichorous, another while semi-purulent; and in different constitutions, an erythema, a papular eruption resembling lichen, a vesicular eruption, or a squamous eruption.

It is customary to denominate an eruption of dry pimples—lichen, a misapplication of a classical term, but one in common use. It becomes necessary, therefore, to distinguish between the papules of eczema and that form of papule which merits the distinction. A papule which is a part of eczema clearly belongs to that disease, hence the term eczema papulosum: but there are certain pimples resulting from folliculitis which cannot at any stage be regarded as appertaining to eczema. Such are, a pale papule described by Willan under the name of strophulus; an itchy papule allied with nettle-rash, lichen urticatus; a papule which would appear to be the product of scratching in prurigo; a papule which embraces the shaft of a hair, lichen pilaris; and notably a pimple of quadrate figure and smooth flattened summit, the lichen planus.

Lichen, as just intimated, is a papular prominence of the skin caused by hyperæmia of a follicle; that is to say, folliculitis. But as the follicle is an integral part of the skin, we must explain under what circumstances a congested follicle becomes entitled to a separate designation. To realize this occurrence we are bound to recognize an inflammation of the skin which is simply superficial, such as an erythema, and another, albeit differing in degree alone, which sinks more deeply into the skin, and implicates the vascular lining of the follicle as well as the interfollicular papillary stratum. It is this implication which gives rise to a punctated erythema, and, in a more advanced stage of progress, to a prominence or papule ranging in height from the merest roughness to a distinct conical pimple, susceptible of running on to further developmental changes. Let us, for example, take the puncta of measles, which on the face very frequently become minute papules, which are distinct papules in scarlatina, and which become vesicles and pustules in the case of variola. Papules may in this way become a complication of every form of inflammation of the skin.

But, besides being a complication of other forms of cutaneous congestion, inflammation of the follicles may also assume an independent rank. Thus, in a languid condition of the skin, such as is frequently present at puberty, a state of congestion of the follicles of the face, chest, and back constitutes *acne;* a similar but more transient inflammation of the follicles may be induced artificially by the internal administration of the iodides or bromides, or the external use of tar. A prolonged use of poultices will give rise to a pustular folliculitis, as also will frictions with tartarized antimony. Hence we are led to a consideration of the follicle of the skin as an independent organ, and are enabled to note its pathological phenomena. The pustules of the skin take their origin in the walls of the follicles; and excessive congestion of the follicles, with want of vital energy, gives rise to an inflammation accompanied with gangrene and sloughing. Such, in fact, in a minor degree, is furunculus and, in a more exasperated form, carbuncle.

The normal course of inflammation, wherever it occur, is necessarily modified by the constitution of the individual, and inflammation of the skin forms no exception to this general rule. The chief sources of modification are—blood-poison, as in the instance of the exanthematous fevers, rubeola, scarlatina and variola, syphilis and elephantiasis; together with defective nutritive power and cachexia in the case of lepra vulgaris and struma, the latter comprehending lupus vulgaris. The essential modification presented by the exanthemata is regularity of course; the course of syphilis is equally precise, but less definite; and the same may be said of elephantiasis. All these examples are mere repetitions of one primary type; that is to say, they present erythema, papulation, vesiculation, and pustulation; but they differ among themselves in that the exanthemata are acute, syphilis and elephantiasis chronic, and lepra and struma more chronic still. The acute forms end with pustulation and sometimes gangrene; the chronic forms, with the exception of lepra vulgaris, run into ulceration. This concatenation of pathological lesions is strikingly evinced by dermato-syphilis, in which the first outbreak is an erythema, the second a papule or tubercle, and the third an ulcer.

The constitutional and cachectic nature of struma, which embraces lupus, is universally recognized; and it is to an inherent constitutional debility of tissue that we must attribute lepra vulgaris. In the latter instance, chronic congestion of the skin, by inducing a fuller state of its capillaries and detaining in its tissues a larger quantity of the prime agent of nutrition, namely blood, gives rise to hypernutrition or hypertrophy; there is more or less fulness or prominence of the morbid patches, the papillæ cutis are increased in bulk, but most conspicuously there is an increment from hypertrophy of the substance of the epidermis, in the form of laminæ or scales, which are white and glistening, porous and spongy. The lepra vulgaris thereby becomes identified as the type of squamous affections of the skin, and the whiteness of the scales is conveyed in its subjective synonyms—alphos and alphoides.

Aberration of nutrition of the skin is evinced in its simplest form by defect of growth; the skin may be too small for its contents, or it may be thin and, as it were, starved. Pathology affords evidence that the quantity of nerves, vessels, and succulent elements is reduced; whereas the mere vegetative constituents of the epidermis, although altered in quality, may appear in excess, partly from suspension of elimination, and partly because the formation of epidermis makes a less demand on the constitution than the more highly vitalized tissues. The condition of the skin under these circumstances may be easily predicted: it will be dry, *dermato-xerasia;* the accumulated epidermis will assume the appearance of the scales of the fish or of the serpent, and so the state termed *ichthyosis* will be established; while in other cases the superaddition of tenacious sebaceous matter to the epidermic plates increases their bulk, and constitutes the so-called ichthyosis spinosa or hystrix. Ichthyosis has been defined as an hypertrophy of epidermis, but such a definition is wholly inadmissible; as well might we define eczema as an hypertrophy of incrustation. The term hypertrophy is wrongly applied when it is used to signify excess in quantity; excess of growth from hypernutrition is its more correct signification.

Instead of a starved condition of the skin, such as occurs in ichthyosis, an actual hypernutrition or hypertrophy of tissues is met with, in warts; and likewise in angioma or vascular nævus, where a congeries of capillaries forms a stratum or tumour of variable extent. Another form of aberration of nutrition is illustrated by the increment of connective tissue and condensed fibrous tissue in the skin—in the former instance giving rise to soft connective-tissue tumours, called molluscum; and in the latter to cheloides and scleroderma. In the former of these cases the tendency is to the accumulation of fibrous tissue in mass, and in the latter to the substitution of white fibrous tissue for the more highly organized structures, inducing, in fact, an atrophy, and giving the affected part the appearance and character of a cicatrix.

Aberration of nutrition is also shown in those small pigmentary masses, termed *xanthoma;* in those masses in which black pigment prevails, *melanoma;* in substitutions of epitheloid for the normal tissues, *epithelioma;* and in accumulations within the substance of the skin of lymph-cells, constituting *lymphadenoma.*

The innervation of the skin, represented by the nervous system, presents us with aberration of function, in the form of excess and diminution and of perverted sensation. A highly wrought sensitiveness not unfrequently comes before us; more commonly it is the opposite condition that occurs. Both of these states are present in elephantiasis. And then we have perverted sensation in prurigo and pruritus; the former indicating a confirmed disturbance of the whole nervous system, the latter a temporary irritation—sometimes reflex, as in urticaria; and sometimes local, as in eczema.

Convenience has suggested the consideration of the appendages of the skin under a separate head, in order to avoid disturbing the consecutive character of the pathological phenomena of the skin in a state of disease. But even in the case of the appendages we shall have to revert to our previous arrangement. One while the disorders of the appendages will be found to be referable to ordinary inflammation, another while to modified inflammation, and thirdly to aberration of nutritive function. This will be obvious when enumerating the cutaneous appendages; for example, the cuticle and nails, the hair and hair follicles, and the glandular system of the skin, sebaceous and sudoriparous.

The diseases of the epidermis, besides variations in quantity and quality of horny material, are manifested by changes of colour and texture; pigmentary alterations of the skin are due to aberration of function of the rete mucosum; while a peculiar state of proliferation of the cell-elements of the mucous layer is by some authors regarded as a vegetable fungus of parasitic origin. Under the head of discolouration or dyschroma, we range melasma, chloasma, ephelis, lentigo, and achroma; whereas the so-called fungus-affection has received the name of phytosis, which expresses the pathological change, and of pityriasis versicolor, which alludes to a kind of desquamation with which one of its forms is accompanied, and to a pigmentary discolouration.

The nails may be diseased in relation to the vascular skin in which they are embedded, constituting onychia; or they may present changes analagous to those of the epidermis, of which they are a part; in this latter sense being altered in colour, figure, density, and cohesion, or distorted by accumulation of imperfectly formed cell-elements, as in the case of onycho-gryphosis.

The hairs likewise may be altered in quantity, texture, and colour; or they may undergo the change already noted in connection with the epidermis, a phytiform proliferation which renders them brittle, and causes them to break off close to the head, producing the bare patches known as ringworm. In ringworm there are always stumps and roots of hairs, and the epithelium of the follicles participates in the morbid change; whereas in alopecia, and notably in alopecia areata, there exist atrophy of the skin and total absence of the hair more or less permanent.

The follicles of the skin, taken as a whole, constitute an encrypted surface of very considerable importance and extent, and while it participates in the manifestion of pathological conditions common to the whole of the exterior surface, presents certain phenomena of disease which are peculiar to itself. We have already noted the hyperæmia of the follicles in erythema, eczema, lichen, ecthyma, furunculus, and the exanthematic fevers, and now we come to the consideration of their congestion and inflammation in acne and rosacea; their suppuration in mentagra and kerion; their dilatation in comedo, follicular tumours, and encysted tumours; their phytiform derangement of nutrition and growth in favus; and the malignant transformation of their cell-tissues in epithelioma.

The glandular apparatus of the skin supplies us with steatopathic and idrotopathic affections, which are one while an alteration of their secretions and another while of the structure of the glands. The sebaceous secretion may be excessive or defective, too moist or too dry, or altered in its colour; while a hypertrophic growth of the glands by pushing them above the level of the skin, so as to form small tubercles, constitutes one of the forms of molluscum, namely, *M. adenosum* or *contagiosum*. In like manner, the perspiratory secretion may be excessive or defective, altered in colour or in odour; and in rare instances the glands themselves may be inflamed and become hypertrophied, or issue in suppuration.

Prognosis.—In considering the prognosis of diseases of the skin, it will be necessary to eliminate from their number—scrofula, syphilis, cancer, and elephantiasis. The prognosis of these affections is the prognosis of the parent disease; and yet in these diseases there arises the distinction between that which is hereditary or inherent, such as scrofula and cancer, and that which is accidental, *e.g.*, syphilis and elephantiasis. With regard to the remainder of cutaneous affections, it may be said that they are more vexatious than dangerous, and that a fatal tendency, wherever it prevail, lies in the constitution of the individual, and not in the disease itself. They are remarkable for their tediousness, and they make a demand on the constitution for a considerable amount of endurance; but when the enduring power is weak, and the vitality of the individual low, they naturally tend to shorten the continuance of life. In a tedious case of eczema, it is not the pathological affection that we have to contend with, but the feeble energy of the powers of the constitution. In another very chronic affection, lepra vulgaris, which frequently lasts an entire lifetime, the constitution may possess considerable vigour, and yet the disease be perpetuated because it is due to an inherent debility of the skin itself. In other words, therefore, it may be said that diseases of the skin are troublesome, but rarely grave.

CAUSE.—A knowledge of the cause of cutaneous diseases is absolutely essential to their treatment; and the principal causes may be grouped into external and internal, local and general. All irritants, including heat and moisture, parasitic animalcules, bites, stings, punctures, and scratches, are causes of hyperæmia and eczema. Local disturbances of innervation and circulation, particularly obstruction of venous circulation as evinced by chronic eczema of the legs, are fruitful causes of cutaneous hyperæmia and its consequences. Other causes reside in the insufficient vitality or defective structure of the skin itself, as may be seen illustrated in lepra vulgaris, ichthyosis, and lupus; whilst a still larger field is opened out in the case of errors of assimilation and nutrition, which may one while produce an erythema or an eczema, and another while a ringworm. Moreover, a feeble or irritable state of the nervous system gives rise to certain affections especially characterized by neurotic phenomena, which may be due to the operation of an especial irritant, or may depend upon an organic alteration in the nerve structure itself.

TREATMENT.—Our descriptive diagnosis, our prognosis, and enumeration of causes have, it is hoped, led our reader onwards to a perception of the principles of treatment which we believe to be sound and the best suited to the accomplishment of alleviation and cure. The order which we have adopted is therapeutical, as well as pathological. Our *first group* of diseases is composed of such as are dependent on ordinary constitutional disturbance, in which the treatment must be simply constitutional — antiphlogistic, depurative, derivative, and tonic. In the *second group*, which are modified by peculiar conditions of the skin itself, or by the operation of special poisons, our treatment must be specific. In a *third group* our efforts must be directed to the improvement of the nutritive condition of the skin; and in a *fourth*, to the restoration of the tone of the nervous system; while, in all the preceding groups, due attention must be given to local applications.

As the common cause of the *first group* is indigestion and malassimilation, our remedies are mild saline aperients, and sometimes occasional doses of blue pill. But we must combine tonics with our aperients, and hold tonics in reserve for restoring the powers of the patient, and in some instances begin at once with tonic remedies. A glance at the leading diseases of this group will show at once the application of this *methodus medendi*, *e.g.*, erythema, eczema, pemphigus, ecthyma, furunculus, anthrax: the two latter remind us that our tonics will be quickly wanted; while in pemphigus they will possibly take precedence of every other consideration.

In the *second group* we enumerate exanthematous fevers, syphilis, elephantiasis, struma, and lepra vulgaris. A survey of these diseases will show at once that their treatment must be different from that of the preceding. The exanthemata we watch simply, and only interfere to prevent causes of aggravation. For syphilis we have our specifics in iodine and mercury. Elephantiasis, at present, has defied specific treatment, and must be dealt with by alteratives and tonics.

Struma makes a demand for our whole *armamentum* of tonics, beginning with nutritious food and cod-liver oil, and running on to iron, iodine, quinine, strychnine, phosphorus, and lime; whilst the pharmacy of lepra vulgaris is limited to arsenic and tar.

In defective nutrition and aberration of nutrition of the skin, the nutrients and the tonics, and our special nutrient tonic, arsenic, are called into requisition.

Disorders of innervation are treated with tonics, and especially with cod-liver oil, phosphorus, quinine, and arsenic. When due simply to nerve irritability, they yield to this treatment; but when they are consequent on an organic change in the nerves themselves, as in some instances of prurigo, and notably in the neuralgia of shingles in elderly persons, they often defy our best endeavours to promote cure.

Diseases of the appendages of the skin must be treated on the above general principles; but, in every case of cutaneous affection, it must be borne in mind that the general functions of the organization must be observed and regulated.

The *local* treatment of diseases of the skin, although second in order, is not necessarily second in importance. As hyperæmia and inflammation are prominent features in these diseases, our first consideration must be to soothe. To effect this purpose, we must remove all obvious causes of irritation, and then have recourse to our recognized palliatives. Any mild and unirritating powder, such as fuller's earth, is known to relieve heat and hyperæmia of the skin; oxide of zinc and lime water (in the proportion of one drachm to an ounce) will form a white-wash over the inflamed surface which is peculiarly soothing. Next to these remedies we may enumerate the benzoated oxide of zinc ointment, softened by the addition of an eighth of spirits of wine. Ordinary erythema and erythematous eczema may require no other treatment than the above powder and lotion; while a smart attack of humid eczema will possibly need no additional external remedy from one end of the treatment to the other. When we come to the chronic period of eczema, a mildly stimulating ointment, such as that of the nitric oxide or ammonio-chloride of mercury, may be serviceable; and if there be sluggishness with pruritus, a preparation of tar, either in the form of lotion or ointment. During the whole course of this treatment washing should be avoided; it disturbs the healing process, and, however agreeable for the moment, is always followed by an exacerbation of irritation.

There is a moment, however, in the course of the treatment of eczema, when water-dressing or "envelopment" may be serviceable, and that is when the tissues are distended with infiltrated fluids, and nature of herself is unable to expel them through the skin. In such cases, the heat and moisture of "envelopment" serve to facilitate the process; but the treatment, however useful for a temporary purpose, is debilitating as respects the tissues, and must not be continued too long. The surface must soon be washed and dried, and the zinc ointment, with a covering of wash-leather, resumed as in ordinary cases.

Pemphigus, being a disease of exudation, is especially benefited by the lotion of lime water and zinc of moderate consistence; erythema is to be treated in a similar manner; while furunculus may be held in check by liquor plumbi painted on the surface, or by a plaster of galbanum and opium on wash-leather. The severe tension of furunculus is relieved by a granule of potassa fusa introduced into the aperture of the swelling, whilst the most suitable dressing when ulceration is established is the yellow basilicon ointment.

In the local treatment of the exanthemata, it should never be forgotten how much comfort is derivable from a thin coating of grease of any kind, although the oxide of zinc ointment is especially suitable for the purpose. There should be no washing or sponging, but only gentle wiping on each repetition of the unguent. The advantages of local treatment are also strikingly exhibited in variola, not simply as a means of relieving heat and itching, but as a most successful method of prevention of pustules.

Syphilis, save in the instance of ulceration, requires no local remedy for its treatment; black wash may be painted on the ulcers, or they may be dressed with a mild mercurial ointment; but their cure is to be found in the constitutional treatment. Even elephantiasis admits of relief from inunction with stimulative liniments or ointments. Strumous sores need the assistance of gently stimulating ointments and tinctures, and lupus the application of nitrate of silver and potassa fusa. In lepra vulgaris, severe frictions with preparations of tar are especially indicated.

In the group representing aberration of nutrition, the first example—the dry, impoverished, and sordid skin of ichthyosis—calls for abundant inunction with any bland grease, such as oleum theobromæ, unguentum petrolei or vaseline, and thorough saponaceous ablutions. Verrucæ may be removed with pyroligneous acid or potassa fusa; angeiomata with the latter caustic or with the knife; molluscum, when sufficiently important, with the knife; while cheloides and scleroderma should be closely covered up with any unirritating plaster, such as that of the compound soap cerate spread on soft leather; and epithelioma must be speedily "stamped out" with caustic or with the knife.

Disorders of innervation, represented by pruritus and prurigo, are relieved by lotions and inunctions of carbolic acid, creosote, and tar, or lotions of hydrocyanic acid; and neuralgia zosteri by hydrate of chloral and camphor, and by liniments of aconite, belladonna, camphor, and ammonia.

Affections of the appendages of the skin are to be treated locally on the general principles already indicated. Dryness and roughness of the epidermis and nails are relieved by saturation with some unirritating grease; pigmentary discolourations may be removed by borax in lotion and ointment, and an ointment of bismuth; and phytosis or pityriasis versicolor by an ointment of sulphuret of potash, or an emulsion of almonds with the perchloride of mercury (one or two grains to the ounce). Onychia will require the oxide of zinc ointment and nitrate of silver, and onycho-gryphosis a solution of chloride of zinc inserted beneath the nail, and subsequent dressing with the oxide of zinc ointment and a bandage.

The affections of the hair-follicles and hairs have each their separate local remedy. For tinea, there is no better one than the nitric oxide of mercury ointment, combined with two-thirds of any diluting medium; for general alopecia, a mildly stimulating lotion, such as one containing ammonia and chloroform; and for alopecia areata, painting with epipastic fluid diluted with distilled vinegar in equal proportions, followed by frictions with tar.

Acne vulgaris and acne rosacea should be stimulated with the hypochloride of sulphur ointment; mentagra, by frictions with the iodide of sulphur or nitric oxide of mercury ointment, both diluted to the extent of two-thirds; whilst the best local application for suppurative inflammation of the follicles of the scalp, or kerion, is the liquor plumbi pencilled on the blotch, and when dry moistened with benzoated lard. Finally, the tubercles of molluscum adenosum require to be pencilled with the compound tincture of iodine. In all the affections of the sebaceous and sudoriferous system, ablutions with tar or carbolic acid soaps are valuable means of maintaining a healthy stimulation of the skin.

DIVISION II.

INJURIES AND DISEASES OF ORGANS AND REGIONS.

THE HEAD.

CHAPTER XLII.

INJURIES AND DISEASES OF THE SCALP, CRANIUM, MEMBRANES OF THE BRAIN, AND BRAIN.

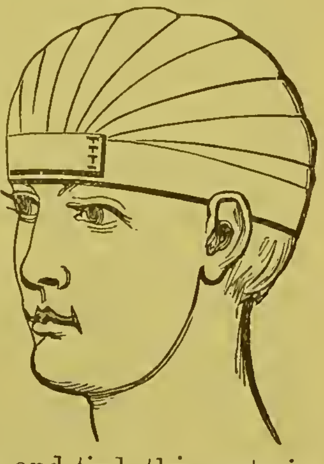
INJURIES OF THE SCALP.—WOUNDS.—The integument covering the skull is liable to wounds resembling those of the soft parts in any other situation. Scalp-wounds may therefore be incised, punctured, or lacerated and contused; and these lesions are of very common occurrence. They have two peculiarities worthy of notice—a marked tendency to heal by primary adhesion, however extensive the wound and detachment of the scalp from the pericranium; and, on the other hand, a special liability to the supervention of erysipelas, suppuration, and sloughing. The favourable character of these wounds seems owing to the greater vascularity of the scalp as compared with the common integument; the unfavourable character alluded to seems to be of constitutional origin, erysipelas of the scalp occurring only or chiefly in persons of " broken " constitutional health.

Treatment is the same as that of wounds in general; but the circumstances referred to encourage the attempt to *always* solicit union of the scalp, even when extensively incised or lacerated, and detached; and yet render doubtful the issue of even the slightest scalp-wound. Any hæmorrhage may be arrested by compression, or, if necessary, by torsion or ligature; but the bleeding usually ceases by sponging with cold water. The integument around the wound should be shaved, and cleansed of any hair, grit, or other foreign body; then laid down and replaced, if detached, and the lips of the wound neatly brought together; strips of adhesive or isinglass plaster being used to retain them in position, aided, if requisite, by a wire suture here and there. Care should be taken, as Neudörfer observes, that the lips of the wound be not inverted, lest the growth of the hair-stumps should interfere with union taking place. Water-dressing is applied, by a strip of lint, to any part that cannot fairly be drawn together. A bandage may be used, but it should be applied as lightly as possible, consistent with its use. This dressing need not be reapplied for twenty-four or forty-eight hours, by which time primary union will often have commenced. In the event of *suppuration*, bagging must be prevented by giving a free vent to the matter from the wound, or by an early counter-opening in the most dependent part, or by means of compresses properly applied. With erysipelas or diffuse cellulitis supervening, incisions will be more especially necessary, both to relieve tension and to discharge matter and sloughs. The dressing is exchanged for a poultice. Exposure of the *bone* is not always followed by exfoliation, or any occasion, therefore, for further interference, to remove dead bone; granulations freely springing up around, and in islets which coalesce and overspread the bone, the wound heals by this process. Water-dressing or a stimulating lotion, according to the state of the granulations, must be continued as usual, until cicatrization is completed.

Medicinal treatment consists in moderating the circulation by gentle aperients, with a restricted diet, especially as regards stimulants; followed by a tonic and supporting plan of treatment, in the event of suppuration or erysipelas. Rest has an important influence, as favouring the process of reparation, and is of the utmost consequence with regard to the liability of cerebral symptoms.

Bandaging the Head.—Various forms of head-bandage are in use. The *capelline* is the most close-fitting, and therefore best adapted to retain any dressing in position. It is thus applied: Take a double-headed roller, about two inches wide; lay the middle of this roller flat upon the forehead, just above the root of the nose, and draw either end, at the same level, around the head laterally to the occiput, below the protuberance; then cross them, and bring one end over the top of the head to the forehead, low down, the other end being drawn around the side of the head across the vertical turn, to fix it in place; this turn is then carried back over the head, partly overlaying the first turn; at the occiput, the encircling band again crossing the vertical reflexion, keeps it in place at that point. By this cross-bandaging—vertical turns of the bandage backwards and forwards, retained by the horizontal turns, the head is completely covered as with a cap. (Fig. 593.) Or, the *handkerchief cap* can be more readily applied, by folding an ordinary large-size handkerchief double, in a triangular form; then, placing the base of the triangle just above the brows, while, the triangular portion lying on the head, the apex falls below the occiput, the ends of the handkerchief are drawn backwards around the head across the apex, and then back again to the front, where they are tied on the forehead. A *four-tail* bandage may be made out of a handkerchief, by cutting or tearing up each side to within a few inches of the centre: this central portion is laid on the top of the head; the anterior ends are drawn downwards and backwards to the back of the neck, and tied, the posterior ends being drawn across forwards to beneath the chin, and tied.

Fig. 593.



Gunshot wound of the scalp may be complicated by one peculiarity—the presence of a bullet as the foreign body, and which is situated under the integument, at some distance from the wound. This condition will be characterized by the absence of a second wound—the aperture of exit, and of any insensibility, or other brain-symptoms, which would attend a penetrating gunshot fracture of the skull; moreover, the ball can generally be felt under the scalp, though it may be buried deeply, as beneath the muscles of the neck. Wound of this kind is apt to be produced when a round ball impinges obliquely on the skull, and is thence deflected beneath the skin.

Treatment consists specially in removing the foreign body by a counter-opening, rather than by extraction through the original aperture, which should be dressed as a contused wound. But necrosis often ensues, with tedious exfoliation ; a consequence which must not be overlooked with regard to prognosis and after-treatment. Long-continued suppurative discharge, with sloughing, may exhaust the patient; or intra-cranial inflammation supervene. The contingencies of gunshot wound of the scalp are various: secondary hæmorrhage not unfrequently; erysipelas as an occasional consequence, but from no special liability; while traumatic spreading gangrene, pyæmia, and tetanus sometimes occur.

CONTUSION.—Without wound of the scalp, a contusion presents the usual characters of such lesion; but the blood-tumour which forms, varies with the situation of extravasation and the localized state of the blood.

Extravasation may occur in either of three situations: (1) between the skin and the tendinous expansion of the occipito-frontalis muscle; (2) in the loose cellular texture under this muscle; or, (3) beneath the pericranium or periosteum. In either situation, the blood may be infiltrated, or circumscribed more or less in a cavity.

Infiltrated in the dense cellular tissue between the skin and occipito-frontalis muscle, the blood presents a hard unyielding lump; beneath the tendinous expansion, it spreads through the loose cellular texture, forming a swelling of sometimes considerable extent over the head, and which gives a crackling sensation when pressed with the finger. Circumscribed extravasation is apt to form a prominent cuplike tumour, with a soft centre, and a hard circumferential ridge, resembling fracture of the skull with depression; for which injury the blood-tumour resulting from contusion may be mistaken, and the more readily if the swelling in connection with a lacerated artery pulsates. But the *diagnosis* will be determined by three observations: the bone can be felt with the point of the finger, at the bottom of the soft central hollow; the circumferential margin can be indented with the finger-nail, unlike bone; and there are no symptoms of cerebral compression.

The *Treatment* is in no way peculiar. Absorption often taking place, it may be promoted by cold evaporating lotions, which check further effusion. Persistent and increasing extravasation will justify evacuation of the fluid. This should be done by a small puncture, after which compression is made and continued over the whole swelling. In large collections, these puncturings may have to be repeated several times; and in an encysted collection of large size, if the fluid has become of a serous character, and recurs again and again, an iodine injection might be thrown into the pouch. A small false aneurism sometimes results from extravasation; and this may be cured by compression, or by acupressure with a pin and figure-of-eight suture.

Suppuration occurring, the bag must, as usual, be laid freely open.

CEPHALHÆMATOMA, or blood-tumour of the scalp, forms sometimes in newly born children; in consequence of pressure during parturition, or in delivery by obstetric forceps.

The pathology of a blood-tumour thus produced, is much the same as of that arising from an ordinary contusion of the scalp; the blood collecting beneath the tendinous aponeurosis of the occipito-frontalis muscle, or beneath the pericranium.

Subaponeurotic cephalhæmatoma presents a bag of blood, of soft fluctuating consistence and some size, with a rather hard boundary, situated over the eminence of one of the parietal bones. This blood-tumour is not peculiar to newly born infants; it occurs also, and perhaps more frequently, on the head in children, as caused by a fall or a blow. But it is the more common form of tumour.

Subpericranial cephalhæmatoma has sufficiently distinctive characters. The blood-tumour is still soft in the centre, but circumscribed by a firm, raised border or margin, giving a relatively depressed appearance to the centre, or which feels hollow when the finger is inserted. The whole condition might be mistaken for a depressed fracture, with the adjoining margin of bone. But there are no brain-symptoms; and perhaps the bone can be felt at the bottom of the depression. This species of blood-tumour, like the preceding, usually occurs on the parietal bone. Valleix has shown that the extravasation of blood, situated between the pericranium and bone, is surrounded by a deposit of osseous and plastic matter, forming a hard ring around the blood; and that the inner aspect of this ring is almost vertical, while the outer aspect inclines down to the adjoining surface of the skull. This plastic boundary is adherent both to the bone and pericranium; but, except a covering of plastic matter, these parts have otherwise a healthy appearance. From Sir James Simpson's observations, it seems that the plastic deposit may become ossified, forming a plate of bone on the under surface of the pericranium. Then, the tumour yields a crackling sensation, like parchment, when pressed with the finger. Subpericranial cephalhæmatoma is met with only in new-born infants; at least, such is the generally received opinion. It is the *C. neonatorum* of Naegele, Zeller, and other writers. But I have known a precisely similar description of blood-tumour produced on the forehead of a child five years old, in consequence of a fall on that part of the head. The cephalhæmatoma was situated over the right frontal eminence, was somewhat conoidal, and about the size of a small egg. Its centre felt depressed, and bounded by a firm ring, as if the margin of a depressed fracture; yet without any cerebral symptoms, while the bruised discolouration of the skin declared the nature of the tumour. Any such tumour, occurring at the time of birth, is far more frequently found in male than in female infants; and perhaps more often in first parturitions.

Treatment, with reference to *subaponeurotic* cephalhæmatoma, should be conducted as for the management of ordinary scalp-contusion and extravasation of blood; but the *subpericranial* form of blood-tumour will subside, naturally, in the course of time. Compression, uniformly applied to the tumour, may, however, aid absorption. A parietal tumour, in one of my own cases, was thus apparently urged to disappear; while, in the other case, the frontal tumour subsided without any interference. So also did a second such blood-tumour, after a fall on the forehead, in the same child.

Injuries of the Cranium.—Contusion of the Bone.—Cranial contusion is produced by, and accompanied with, a wound or contusion of the scalp; but it is unconnected with fracture, as being simply a contusion of the bone. It may arise from a fall or blow, of no apparent severity; or from slight gunshot injury, as the brushing abrasion of a spent bullet, striking the head obliquely, and removing perhaps only the hair. Yet the consequences may be very serious or fatal.

Consequences.—(1.) It may lead to *caries* or *necrosis* of the contused bone, affecting one or both tables of the osseous substance; and limited to the seat of injury, or spreading far and wide, even over the whole vault of the skull. In a case related by Saviard, after a blow on the head, the whole skull-cap came away.

The *treatment* for superficial caries, or for exfoliation, is simply that which relates to a piece of dead bone in any other situation. The supervention of brain-symptoms may be prevented or counteracted by the treatment appropriate for Traumatic Inflammation of the Membranes of the Brain.

(2.) *Chronic ostitis* may follow cranial contusion, without any cranial necrosis, but resulting in a thickened state of the bone, or an irregular modification of its internal surface. Hence, pressure upon, and irritation of, the brain induce epileptic attacks or maniacal seizures; especially whenever, from any exciting cause, the chronic inflammatory action is aggravated.

Tenderness, and perhaps slight thickening of the scalp, both of a persistent character, over the seat of contusion, are the only external signs of this chronic inflammation of the cranium.

Treatment consists in topical depletion by leeches, or incisions through the scalp over the affected portion of bone; and, at a later period, the repeated use of blisters, with a course of iodide of potassium and tonics. Trephining the bone has been resorted to for removal of the source of cerebral irritation; but the results of this operation have been too seldom successful to justify the risk of a fatal issue, except in extreme cases.

(3.) *Inflammation* of the *diploe* is another consequence to be dreaded; such inflammation extending probably inwards to the dura mater, with detachment of that membrane and suppuration between it and the cranium. Thus far the mischief is circumscribed; but the inflammation deepening to the arachnoid membrane, it spreads over the parietal layer, and soon involves the visceral layer; thence the pia mater and corresponding surface of the brain. All the membranes and the brain are affected. The pericranium or periosteum separates, and suppuration takes place under the scalp, giving rise to a boggy swelling, circumscribed, flattened, or prominent—the "puffy tumour" of Pott; or the wound, if there be one, loses its healthy florid appearance, its edges becoming everted, and the discharge discoloured, thin, and gleety, while the pericranium separates from the bone, or the latter, if denuded, becomes dry and yellow-white, or discoloured. In removing the dressing from such a sore, the lint sticks to the surface, instead of coming off, as from a suppurating sore.

The symptoms are insidious and supervene at a variable period, perhaps a fortnight or more after the contusion. The earliest local change is in the appearance of the wound, and of the bone, if exposed; or the formation of the small, puffy swelling. Either condition corresponds to the subcranial suppuration. This is accompanied with pains in the head, giddiness, and feverishness; followed by rigors, sickness, drowsiness, occasional wandering, coma, or paralysis and death. Or, if the patient survives, he may suffer from chronic irritability of the brain, or become imbecile, or be subject to epileptic attacks; various derangements of the special senses are not uncommon, such as deafness, defective vision; aphasia sometimes occurs; and hemiplegic or local forms of paralysis may also be apprehended.

(4.) *Pyœmia* is apt to arise—possibly, from a simple wound of the scalp, as a fourth consequence of contusion of the cranial bones. It may occur in two ways; commonly in connection with intra-cranial suppuration; sometimes with suppuration of the diploe, the membranes of the brain remaining unaffected, and the veins of the diploe being apparently the source of purulent infection. Its accession is marked by rigors, greatly increased rapidity of pulse, and prostration.

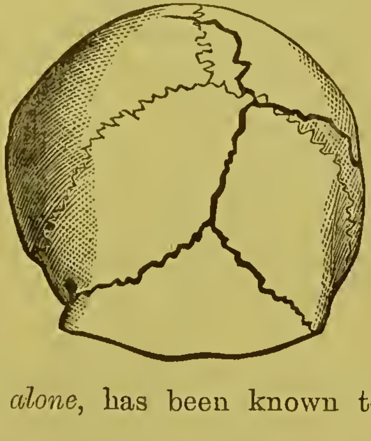
It is very important to bear in mind these four consequences of otherwise *slight* injuries of the head:—death of the bone; or perhaps chronic ostitis; inflammation of the diploe, and its associated inflammation of the membranes of the brain, with intra-cranial suppuration; and pyæmic infection.

The *Treatment* for inflammation of the diploe from cranial contusion will be given in conjunction with Traumatic Inflammation of the Membranes of the Brain.

FRACTURES OF THE CRANIUM.—These fractures are so intimately related, as causes, to Injuries of the Brain, that they should be first considered.

(1.) FRACTURES OF THE VAULT OF THE SKULL.—*Structural Conditions.*—Fracture of any part of the vault may be: (*a*) *Simple* Fissure (Fig. 594), or a comminution of the bone; the former is generally not limited to the seat of injury, perhaps passing through various bones, and often extending from the vault into the base of the skull; the latter, or Comminuted Fracture, is commonly more limited to the seat of injury,—although such fracture may be extensive, as in the cranial smash, or *écrasement*, so named by French authors. Fissured and Comminuted Fracture sometimes co-exist, and especially when caused by a heavy blow acting on a large surface. *Incomplete* Fracture, *i.e.* limited to the external or internal table *alone*, has been known to occur, but comparatively rarely.

FIG. 594.*



(*b.*) *Depressed* Fracture; the displacement of the bone being *inwards* (Fig. 595), or *outwards*, very rarely. Either form of depressed fracture is often *Comminuted;* and the former, or inward depressed fracture, may be a *Punctured* or perhaps stellate fracture, when it is necessarily comminuted, spicular portions of the internal table being driven in. Traumatic depression of the skull, *without* fracture, is not authenticated by any specimen. In the adult, the existence of such injury cannot be acknowledged; and in children, with pliant bones, some of the bony fibres must be broken, forming an *Indented* fracture.

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* St. George's Hosp. Mus., 1, 218A. Linear fracture of the frontal, left parietal, and temporal bones. From gunshot wound; the ball entering, by a circular hole, just behind the external angular process of the frontal bone, on the right side. The inner table is more extensively injured than the outer.

Displacement *inwards* may affect the external or internal table *alone.* The *external table*, Mr. Prescott Hewett observes, may be driven down in any part of the vault, but especially in the region of the frontal sinuses, where the depression may be very extensive, without any injury of the inner table. In *childhood*, when there is no diploe, depressed fracture of the external table alone can only occur over the frontal sinuses, or into the mastoid cells; and in the former situation, I have seen little mischief ensue. From gunshot injury, the outer table may be grooved, as by the angle of a shell fragment or a conoidal ball. The *inner table* may be broken and depressed without a trace of injury about the outer parts of the bone. (Fig. 596.) Such cases are very rarely met with, although in addition to the earlier surgical experience, I find twenty instances of this fracture recorded in the " Surgical History of the American War, 1861–65;" but extensive splintering and depression of the inner table not unfrequently exist, with some slight injury of the outer table. Fracture of the inner or vitreous table is always much more extensive than that of the outer table.

Fig. 595.*

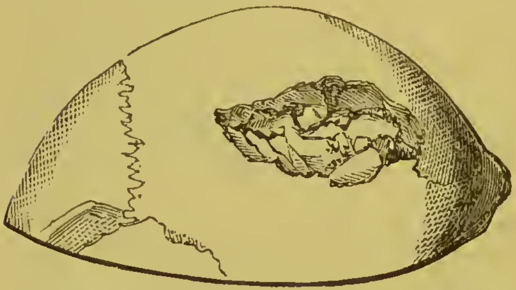
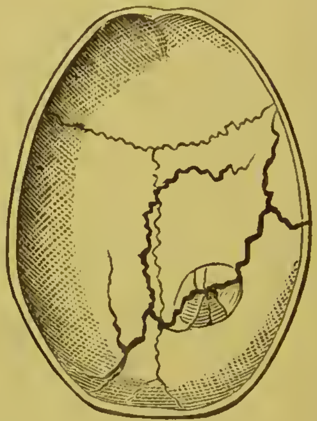


Fig. 596.†



Displacement *outwards* may affect the external table *partially.* Of such displacement there are two specimens in the Museum of St. George's Hospital. In both, a piece involving the whole thickness of the bone, having been detached on three sides, is bent outwards, and thus raised two or three lines above the level of the skull; the fragment is immovable, it being still connected at one side to the surrounding bone, the external table of which, at this part, is only partially fractured. The appearances may, in fact, be said to resemble the lid of a box partly open. In one instance, the injury was produced by a chisel falling from a great height on to the head; and in the other, the patient, in a fall from a great height, struck his head upon some iron railings, one of which penetrated his skull. Upraising of both tables is sometimes produced by fracture from within the skull, as in suicide by firing a pistol into the mouth.

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* Univ. Coll. Mus., 115.

† St. George's Hosp. Mus., 1, 7. Fracture of the skull, with depression of the *internal* table; but no corresponding depression of the external table. On the outer surface (not shown) there is extensive linear fracture of both parietal bones, and in the left parietal, where the blow seems to have been struck, there are numerous fissures in the external table, but without *any* depression. Corresponding to this part, on the inner surface, there is a conical depression of the internal table, formed by a number of small plates converging to a point, and separated by minute fissures. The greatest depth of the depression is about a quarter of an inch. The patient, a man aged sixty-eight, was admitted with a scalp-wound, and symptoms of " concussion;" also fracture of the olecranon. Symptoms of inflammation supervened, after some days, and death ensued in three weeks from the injury.

(*c.*) *Compound* Fracture.—A wound of the integument, leading down to the bone, may accompany every variety of fracture of the vault. But the injury of the bone is very much more frequently strictly limited to the seat of the blow than in simple fracture.

Symptoms, and *Diagnosis*.—*Simple* fracture, in any form, is not accompanied by symptoms or signs invariably and exclusively indicative of this kind of injury. *Fissure* may exist, undiscovered during life; and a *comminuted* fracture, with great depression of the fragments, may be concealed by the temporal muscle, or by a large extravasation of blood. On the other hand, either a circumscribed extravasation of blood, or an abnormal depression of the bone, is apt to resemble fracture with depression. Extravasation into the cellular texture beneath the scalp, raises it, excepting at the part compressed by the contusion. The surrounding swelling thus produced is very firm, and its central margin resembles that of fracture, with depression. But this margin can be indented with the finger-nail, whereas the bone would not yield any impression. Yet fracture may have occurred beneath the annular swelling produced by extravasation; this co-existing injury to the bone will, however, be declared by some symptoms of compression, owing to effusion of blood on the dura mater. Beneath the tendon of the occipito-frontalis muscle, extravasation spreads, and yields a crackling sensation on gentle pressure. An abnormal depression of the skull is congenital, or slowly produced by absorption of the diploe and attenuation of the tables, as sometimes occurs in advancing years. Simple fracture is generally attended with symptoms of *Concussion* of the brain, from the violence causing the injury; the cerebral functions of consciousness, sensation, and voluntary motion are suspended, more or less completely; this state being transient, or of some duration, or soon terminating in death. The patient is stunned; but reaction may ensue, and he recovers in a few minutes; or he lies insensible, motionless, pale, and cold, when vomiting, perhaps, occurs, and the symptoms pass off in a few hours or days; or, complete insensibility remaining, death may take place in a few minutes, or hours at the latest, after the injury to the head. But, with concussion, other symptoms are significant; notably, the state of the pulse and of the breathing, less so that of the pupils of the eyes. Under slight cerebral concussion the pulse is feeble, although often rapid and regular; with complete insensibility, the beat will be scarcely perceptible, slow, and intermittent; or it may be quite imperceptible, in fatal cases. The breathing also is always feeble, but usually placid. On inspecting the pupils, they may be found contracted, sometimes dilated; or one in this state, the other in that.

Depressed fracture is *generally* accompanied by the symptoms of *Compression* of the brain; namely, more or less complete suspension of the cerebral functions of consciousness, sensation, and voluntary motion. But other symptoms present differences of character from those of Concussion, which are more or less diagnostic :—the breathing is slow and heavy, attended with a stertorous or snoring noise; the pulse is slow and laboured; while the pupils of the eyes are generally dilated, and always insensible to the stimulus of light. *Exceptions* to the general rule are, however, met with; depressed fracture occurring sometimes without any symptoms of compression. Thus, when the depressed bone is not firmly fixed, or, in the case of a loose, comminuted fracture, there may be no cerebral compression. Or, in children, the more yielding and elastic texture of the bones may permit of an indented fracture, without symptoms; the bone soon regaining its proper level. In any uncertain case, *with* cerebral symptoms, the Surgeon will be warranted in making an exploratory incision. The same symptoms may proceed from extravasation of blood, or from the formation of purulent matter, under the cranium. But, with depression, these symptoms are immediate; with extravasation, there will be an *interval*, during which consciousness may have been regained more or less completely, as, concussion passed off, the symptoms of compression supervene; with pus-formation, there will also be an interval, during which *inflammatory* symptoms were present, those of compression supervening.

Compound fracture more readily admits of detection, by gently passing the finger or a probe under the scalp; care being taken not to mistake any natural suture or vascular groove for fracture-fissure. Any abnormal disposition of a suture would be especially misleading. The *cerebro-spinal fluid* has been known to escape, as a clear, watery discharge, from the wound, in compound fracture of the vault of the skull; but then the injury must have involved the membranes of the brain,—extending into the subarachnoid space, between the arachnoid and pia mater, or even communicating sometimes with one of the lateral ventricles. This kind of discharge, from the vault, was originally observed by Delamotte, in the case of a child seven years old; a wound on the forehead, leading deep into the skull, gave exit to a large amount of watery fluid, which flowed more freely whenever the child was made to blow his nose. Other instances have since been noticed in the practice of modern Surgeons.

Causes, and their Effects.—Direct violence is almost invariably the *only* cause of fractures of the cranium in its vault, an etiological distinction as compared with fractures of the base. Falls on the head, and blows with almost every kind of weapon, or gunshot injury, as a bullet-wound, represent the occasions of direct violence. In a case of suicide, by firing a pistol into the mouth, I found that the ball had penetrated the base of the skull, and, passing through the brain, struck the roof of the skull; fracturing the inner table, and raising the outer, it fell back into the substance of the brain.

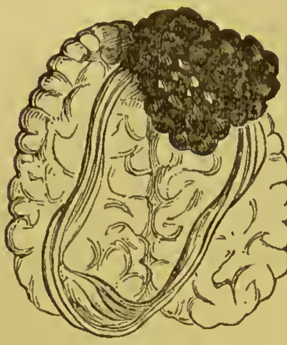
The *relative resistance* of the external and internal tables to direct violence, has been much discussed; and especially in the bearing of this question on the production of *incomplete* fracture, as of the inner table alone. It has been said that the *inner* table is more apt to be broken; and that this comparative liability is owing to its greater brittleness, and lesser extent of surface,—the outer table having greater elasticity, and a wider expanse of surface, it allows of interstitial stretching without fracture, while the unyielding texture of the inner or vitreous table breaks abruptly. But the results of Mr. Teevan's experiments, by artificially producing fractures of the skull, in the dead subject, seem to conclusively disprove both these explanations. For when direct violence is applied to the inner surface of the skull, to the plate of bone alleged to be most liable to fracture, the outer table can thus be broken, without any fracture of the inner. In a case of suicide, by firing a pistol into the mouth, the frontal bone received this form of injury; there was only a black mark produced where the ball struck the inside of this bone, while the outer table sustained a starred, fissured fracture. This notable specimen is in the Museum of Guy's Hospital; and Mr. Teevan fairly adduces it as an instance of accidental injury corroborating his experiments. It would appear that, in the ordinary application of direct violence to the outside of the skull, the external table is compressed, and the inner plate stretched, at that spot; so that fracture takes place just as when a stick is bent across the knee, the fibres yielding first, not on the aspect of compression, but on the side of extension.

In *punctured* or *penetrating* fractures of the skull, the injury may be caused by a sharp-pointed instrument, as a spike or bayonet, or by a bullet in gunshot wound. The relatively greater size of the *aperture of exit*—in either table of the skull, as the case may be—is an important fact; whether from a surgical point of view, or with reference to medico-legal inquiry. This peculiarity has been explained in two ways. It has been urged that, in a penetrating fracture of the skull, the proximal plate of bone suffers less, owing to the support afforded by the distal plate; and thence the larger size of the aperture in this plate. But Mr. Teevan's numerous experiments, respecting this question also, tend to a different conclusion; that while the aperture of entry is produced by the penetrating body only, the aperture of exit, in the distal plate, is made larger by the additional bulk of the fragments of bone driven in from the proximal table and diploe. Consequently, the distal aperture was found to be larger,—whether on the inner or the outer surface of the skull, according to the application of the force on either surface; the table last struck, or to which the force reaches secondarily, is invariably most widely fractured. When, therefore, the apparent support of the distal table was removed, by excising any portion of the bone on that surface of the skull, a bullet fired through the single plate produced, still, only a small, clean aperture.

The accompanying lesions of fracture in the vault of the skull are various. In addition to *wound* of the scalp, occipito-frontalis muscle, and pericranium or periosteum, *extravasation* of blood may take place beneath either of these integuments—parts external to the vault of the cranium. Thus, extra-cranial extravasation is found in one, or more, of three situations: between the scalp and the tendon of the occipito-frontalis muscle, between that muscle and the pericranium, or between that membrane and the bone. The *skull*, *brain*, and its *membranes*, may be severally and similarly involved, as extensions of the fracture-injury to the contents of the cranial cavity. These effects are produced, principally, by depressed fracture. They are separation of the dura mater from the interior of the cranium, wound of this membrane, of the arachnoid, pia mater, and laceration of the brain;

extravasation of blood in the diploe of the skull, or between the bone and dura mater (Fig. 597); or into the cavity of the arachnoid; or beneath the arachnoid and in the pia mater; or into the substance, and ventricles of the brain. No certain relation exists between these effects and the extent of depression. Hence also the want of any certain correspondence between the symptoms of compression and the depression; those symptoms being slight, perhaps, with considerable depression, and severe with slight depression.

FIG. 597.*



The *source* of hæmorrhage varies. Extravasation between the bone and dura mater may proceed from the small vessels passing from one to the other, or from some of the large vessels lodged in the grooves on the inner surface of the skull. The former extravasations—observes Mr. Hewett—are, generally, of small size; but the latter may be very extensive, widely separating the membrane from the bone over the greater part of one side of the skull. The middle meningeal artery is the source of these large extravasations, in the majority of cases. (Fig. 598.) It was so in twenty-seven out of thirty-one cases. One of the large venous sinuses may be the source of extravasation, and the lateral sinus more commonly than any other sinus. The longitudinal sinus was involved in the case from which the specimen is here shown. (Fig. 599.) The situation of extravasation from the middle meningeal artery is usually regarded as the anterior inferior angle of the parietal bone; but extensive extravasations may arise from this vessel, or some of its branches, over nearly the whole of the

FIG. 598.†

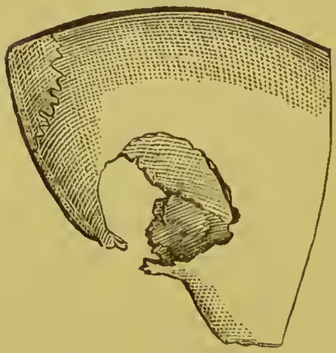
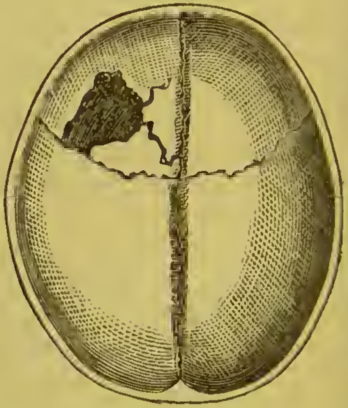


FIG. 599.‡



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* Royal Free Hospital.

† St. George's Hospital, Mus., 1, 248. Depressed fracture of right parietal bone, of circular shape, and about the size of a crown-piece, encroaching on the squamo-parietal suture. The depressed portion, in the form of three angular pieces, two of which are attached circumferentially, was attended with compression of the brain to the depth of half an inch. At the P.-M., a large abscess was found excavating the outer part of the middle lobe, reaching from the surface to the wall of the ventricle, and from the base to within half an inch of the roof of the hemisphere.

‡ St. George's Hosp. Mus., 1, 3. Extensive fracture of the frontal bone on the right side, and involving, apparently, the *longitudinal sinus*. Removal of depressed portion of bone, by trephine and Hey's saw. The skull is that of a young subject.

lateral surface of the skull. So also, with fracture of the base of the skull, extravasations from this source are common.

Intra-cranial extravasation is attended with *Compression* of the brain; denoted by more or less complete suspension of the cerebral functions of consciousness, sensation, and voluntary motion. But—unlike the immediate compression by depressed fracture — these symptoms supervene after an interval, however short; during which consciousness may have been more or less completely regained. The patient again becomes insensible, gradually, as extravasation proceeds; the breathing, slow, laboured, and prolonged, is usually accompanied with a stertorous or snoring noise, and puffing blowing of the lips, or whiffing expirations from the corner of the mouth; while the pulse falls usually, to slow, full, and laboured strokes, as felt under the finger; the pupils are found to be dilated, sometimes contracted, or one may be contracted and the other dilated, but they are always insensible to light, and the eyes fixed, perhaps upturned, or with a squint inwards or outwards. But the progressive insensibility, and peculiar breathing, will first attract attention; and when some consciousness remains or returns, paralysis will be found to have occurred on the side opposite to the injury and extravasation; this hemiplegia being attended perhaps with convulsive twitchings of the muscles, on that side; while, on the other side, the limbs are drawn up. Then also, the urine is retained, and the fæces are discharged involuntarily.

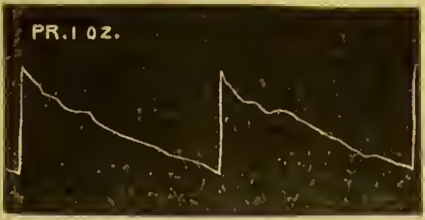
Consequences.—(1.) *Extravasated blood* remains infiltrated, or becomes encysted and undergoes changes of spissitude and colour. In either of the three situations of extra-cranial extravasation, the primary condition, or this alteration, may be found. But with intra-cranial extravasation, blood effused between the dura mater and bone, or in the pia mater, never seems to become encysted; while in the cavity of the arachnoid, it is liable, even prone, to acquire a perfect cyst, if the extravasation be large, or to form tough membranes; such cyst or membrane becoming provided with blood-vessels. These changes are, however, the work of time.

(2.) *Inflammation*, with lymph and pus-formation within the cranium, is always liable to supervene, in consequence of fracture, and in the same situations as intra-cranial extravasation may occur; namely, in the diploe of the skull, between the bone and dura mater, in the cavity of the arachnoid, beneath the arachnoid and in the pia mater, and in the substance of the brain.

Symptoms of inflammation affecting the bone, the membranes, or the brain, are followed by symptoms of *Compression*, as lymph and pus-formation supervene. But—as with extravasation—an interval of time elapses between the fracture and *these* symptoms; an interval of longer duration, usually several days, during which, however, inflammatory symptoms prevail, instead of consciousness returning. The symptoms, therefore, run their course in two distinct stages: cerebral excitement, followed by stupor from compression. The patient complains of headache, becomes restless, and feverish,—as denoted by a rapid, bounding, hard pulse, and hot, dry skin. Contraction of the pupils, with intolerance of light and sound, may also be noticed. Soon, wandering or delirium sets in, sickness, and perhaps convulsions; but the agitation of manner, the wild, glistening eyes, with injected conjunctivæ, flushed face, and throbbing carotids, alike betoken the excited state of the cerebral circulation. The second stage presents a singular contrast; drowsiness, stupor, and coma, with stertorous breathing, a slow, labouring pulse, and dilated state of the pupils, together indicate that effusion has supervened, and compression of the brain; which may be attended with paralysis, convulsive twitchings of the voluntary muscles, and relaxation of the sphincters. Rigors announce suppuration.

"The slow 'cerebral pulse' is generally associated with good arterial tone, and is non-dicrotic, the arteries being contracted rather than relaxed. The systole is of normal length; it is the diastole that is prolonged." (Fig. 600.)

FIG. 600.*



(3.) *Pyæmia*, consequent on fracture of the skull, is mostly connected with inflammation and suppuration of the diploe, implicating some of the numerous and large venous sinuses in the bone.

(4.) *Necrosis* and exfoliation not unfrequently result from gunshot fracture, affecting the outer table alone, or involving the whole thickness of the skull, and even extensive portions of bone have been detached.

TREATMENT.—Fractures of the skull assume importance, wholly in their relation to *brain-symptoms;* whether by the concomitant cerebral concussion, or, by the supervention of compression, owing to intra-cranial extravasation of blood, or to inflammation, leading to effusion and suppuration.

Concussion is naturally followed by reaction; and although, pathologically speaking, there may be an interval, of however short duration, between the occurrence of fracture with concussion, and the supervention of extravasation, yet the insensibility arising from the former state often merges into that of the latter. In practice, therefore, the Surgeon cannot be too cautious not to provoke extravasation, by the injudicious use of stimulants. Warmth to the surface, by enveloping the patient in blankets, with bottles of hot water to the feet, and in the axillæ, will prove sufficient; except in cases of extreme depression of the circulation. Then, watching the restoration of the pulse, attention should be directed to the prevention of *extravasation*, by the prompt adoption of repressive measures. It will be better to err on the safe side of early interference. The patient's head should be shaved and elevated; and the circulation reduced by the application of an ice-bag to the head, coupled with the depletory action of purgatives. I believe an enema of turpentine and gruel to be most efficacious; acting partly as a derivative from the brain. Blood-letting should be had recourse to as the pulse rises *towards* high reaction, with the view of keeping the circulation in check, but not so as to throw the patient back into a state of depression. Extreme depression of the circulation is succeeded by extreme reaction; and hence the propriety of very cautious administration of stimulants, and timely recourse to blood-letting; either measure being indicated and regulated by the state of the pulse. Venesection will make a more decided impression on the general circulation, than cupping on the nape of the neck.

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* Pulse after injury to the head; 48 per minute. By Dr. Mahomed.

When extravasation does not occur,—when the patient does not lapse again into a state of insensibility,—with reaction from concussion, congestion of the cerebral vessels often remains; and thence the liability to intra-cranial *inflammation.* The same precautionary measures must still be directed towards keeping the circulation in check. Cold to the shaved head, depletory purgation, with a moderated diet, and perfect rest, may prevent the development of inflammation. On the accession of the first symptoms—headache, sleeplessness, and feverish excitement—then, again, blood-letting will become a justifiable resource; the Surgeon still watching its permanent effect, not so much on the pulse, as in relation to the brain-symptoms. Topical bleeding may suffice, by leeches to the temples, or cupping on the back of the neck; or venesection, by small and repeated bleedings, rather than one large loss of blood. A depletory and sedative action on the circulation may be maintained by antimonial salines; while the old-fashioned pill of calomel and opium will certainly prove beneficial, when its influence is carried to slight salivation. Subsequently, a continued derivation from the head should be secured by blistering, dressed with savine ointment; while tonic and supporting measures are gradually adopted, to renovate the general health.

Such is the course of treatment, with reference to brain-symptoms, as incidental to fractures of the skull; as arising from other and various causes, the general pathology and treatment of these cerebral affections will be fully considered under the titles Concussion, Compression, and Traumatic Inflammation of the Brain and its Membranes.

Repair.—Fracture of the vault of the skull may undergo repair, either by ossific union, or by the formation of a membrane which becomes the seat of ossification,—thus closing in a large aperture. Both these modes of reparation are well illustrated by two remarkable specimens. (Figs. 601, 602.) (*a.*) Old fracture of frontal bone, with *depression;* and firm *osseous union.* The depressed portion of bone is the size of a crown-piece, and presents a double edge above, as of two steps. The depression externally more than equals the entire thickness of the skull; and internally—not shown—the projection is very well marked. A dissecting-room specimen, with no previous history. (*b.*) Fracture of the left parietal bone, and extensive removal of a portion of the bone. Reparation, by the formation of a *layer* of new bone, proceeding from the end of the fracture, and nearly closing up the large aperture, except in one or two parts, where the dura

FIG. 601. (*a.*) *

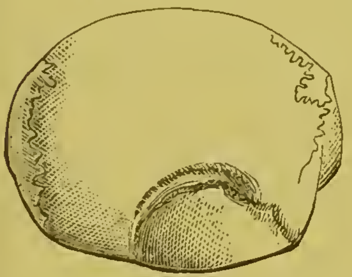
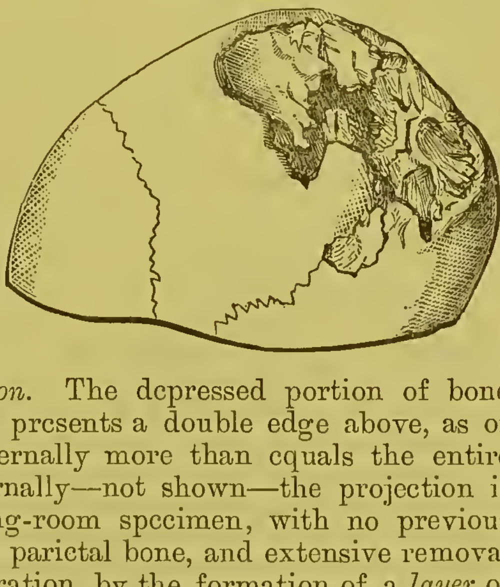


FIG. 602. (*b.*) †



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* St. George's Hosp. Mus., 133.

† Univ. Coll. Mus., 114.

mater alone covers the cerebral hemisphere. The patient lived forty-five years after the injury.

The question of *operative* interference turns principally on the presence, or absence, of Compression-symptoms; and partly on the presence, or absence, of Compound fracture—a wound leading to the seat of fracture.

The rules of treatment are, for the most part, thus expressed by Mr. Hewett; and which are in accordance with the soundest judgment, as well as the largest experience:—

Linear fracture or fissure, unaccompanied by brain-symptoms, even although compound, should not be interfered with; the wound must be treated according to circumstances, and the case carefully watched for some time.

Comminuted fracture, even with depression of the fragments, but unaccompanied with symptoms and a wound, should not be interfered with. It is now an established rule in our Metropolitan Hospitals, that *Simple* fractures, with depression but without symptoms, are to be left alone. The depression may be so marked as to be easily detected; but so long as there are no symptoms, all operative interference, of whatsoever kind, should carefully be avoided.

Compound fracture, with depression, although unattended with symptoms, justifies recourse to operation, and without delay. This rule was inculcated by Sir A. Cooper and Sir B. Brodie, to prevent intra-cranial suppuration consequent on this condition of fracture. The former authority observes: "The elevation of the bone is never followed by any mischief; but if you do not raise it, and inflammation follows, it will then be too late to attempt to save the life of the patient." On the other hand, the *presence* of symptoms in this condition of fracture is the only warrant for operative interference, in the experience of Sir Philip Crampton. "In Dublin," he remarks, "we conform generally to the rule originally laid down by Dease, who preceded Desault by many years; that in fracture of the skull with depressed bone, whether complicated by *wound* of the scalp or otherwise, no attempt should be made to raise the depressed bone, unless very decided symptoms be present of compressed or irritated brain."

Punctured fracture—sharp splinters of the inner table being driven in, albeit without symptoms—most imperatively demands operative interference.

But certain *exceptional conditions* of ordinary compound fracture may be noticed. A slight depression, especially when it corresponds to the thicker part of the injured bone, does not require an immediate operation. A deep driving-in of the bone over the frontal sinuses is another exception; always remembering that these sinuses do not begin to form until several years after birth. A compound fracture with depression, but without symptoms of inflammation, some days after the accident, should not be submitted to operation; and the less so, if the depression is broad, and the fracture comminuted. Such a condition may proceed to recovery without any intra-cranial inflammation. So far, then, respecting fractures of the skull *without* brain-symptoms, in regard to their rules of treatment.

Depressed fractures, accompanied *with* primary brain-symptoms, may be thus represented:—*Simple* fracture, with the symptoms not very urgent, justifies the postponement of operation; but if there be urgent symptoms, prompt interference is the rule to be observed.

Compound fracture depressed, and with symptoms, assuredly demands immediate interference. It may or may not prove successful, according to the urgency of the symptoms, owing rather to extravasation of blood, or brain-lesion, than depending on the fracture-depression.

From the results collected by Mr. John Adams, it appears that out of 77 cases of compound fracture, 29 recovered, and 48 proved fatal; 26 were not subjected to surgical interference—of these 18 recovered and 8 died; 51 were operated on, and of these 11 recovered, and 40 died. The experience of American Surgeons * has, however, been far more favourable; for in 26 depressed fractures, not caused by gunshot wound, the results of the removal of fragments and trephining were complete recovery in 4 cases, partial recovery in 8, and death in 14 cases, or about the proportion of 1 in 2.

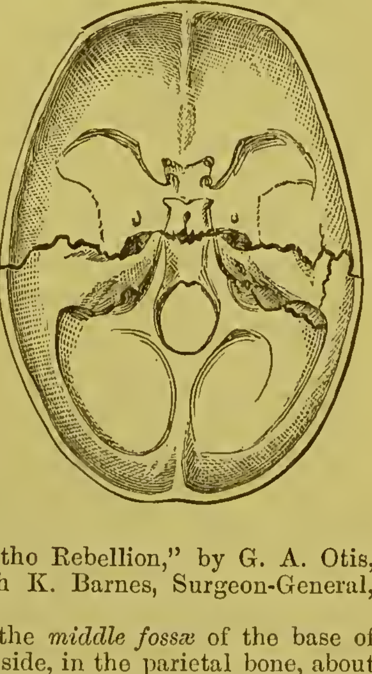
In childhood, a depressed piece of bone does not generally produce the serious results which are commonly noticed in the adult. The postponement of elevation or trephining is, therefore, allowable; when in an adult the operation should be performed at once.

These conditional rules of modern treatment respecting fractures of the skull, have entirely superseded the indiscriminate recourse to operation, which formerly prevailed, both in this country and on the Continent; a reform which dates from the criticism of John Bell on the almost incredible records of the past, and which were satirized by the humorous precept of Hudibras:—

> "The free trepanning of the skull,
> As often as the moon's at full!"

(2.) FRACTURE OF THE BASE OF THE SKULL.—*Structural Conditions.*—Commonly a fissured or radiated fracture, there is little or no displacement, the bones being nearly immovable. The fracture may be situated in either the middle (Fig. 603), posterior, or anterior fossa of the base, and generally in this order of occurrence—the fissure passing through the petrous portion of the temporal bone, or into the foramen magnum. Two fossæ may be implicated; as the middle and posterior, in fifteen cases out of twenty-nine; or the middle and anterior, in the remaining fourteen cases. All three fossæ may be implicated concurrently; but this happened in only ten cases in ten years.

FIG. 603.†



Symptoms and Diagnosis.—The only peculiar and reliable symptoms of fracture of the base are the escape of some of the contents of the skull: *blood*, through the ears, nose, and mouth, or into the orbit; a *serous fluid*, probably the cerebro-spinal fluid, from the ears or nose; or *brain-substance* possibly; accompanied with special symptoms of injury to the cranial nerves as they emerge from the skull. Thus loss of smell or of sight, facial paralysis and deafness, pharyngeal paralysis and aphonia, may severally be indicative of fracture of the base; although the same symptoms may also occur from injury to the brain, without fracture.

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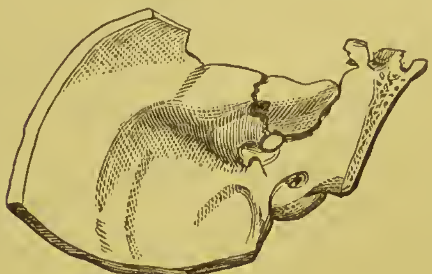
* "Med. and Surg. History of the War of the Rebellion," by G. A. Otis, Assistant Surgeon, under the direction of Joseph K. Barnes, Surgeon-General, United States Army, 1870, Part I. vol. ii.

† St. George's Hosp. Mus., 1, 25.—Fracture in the *middle fossæ* of the base of the skull. The fracture commenced on the right side, in the parietal bone, about an inch from the occipito-parietal suture; it ran forwards for about an inch and

But all these symptoms vary with the *situation* of the fracture.

In the *middle fossa*, there is probably fracture of the petrous portion of the temporal bone, with rupture of the tympanum (Fig. 604), and thence the escape of watery fluid, or blood, from the ear. A copious discharge of watery fluid from the ear, immediately after the accident, leaves no doubt that such is the nature of the injury. A copious and prolonged bleeding from the ear, followed by a watery discharge, also indicates the same injury — fracture of the petrous bone. A discharge of blood, neither copious nor prolonged, followed by watery discharge, varying in the time of its appearance and its quantity, renders the diagnosis doubtful. The discharge of blood is—according to recent experience, Mr. Hewett affirms—certainly not of a character to warrant the diagnosis of fracture of the petrous bone; while a watery discharge may occur a few hours after the accident, and may even be profuse in quantity, and yet there be no fracture. In the *posterior fossa*, fracture is more obscure; unless it extend into the petrous bone. But posterior fractures of the base are sometimes attended with extravasation of blood from the large venous sinuses into the cellular tissue of the mastoid region, or at the back of the head. In the *anterior fossa*, fracture is attended with extravasation of blood into the orbit, thence under the ocular conjunctiva, and eyelids—the lower one first, in most cases. Hæmorrhage from the nose, also, not

FIG. 604.*



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then turned downwards, passing through the mastoid portion of the temporal bone, through the external auditory foramen, the spheno-temporal suture, and the junction of the body of the sphenoid with the basilar portion of the occipital bone; then almost in the same direction upwards on the left side, and terminated in the left parietal bone, rather lower and further forwards than on the right side. When the skull-cap was removed, the anterior half of the base readily moved on the posterior. This extensive injury was produced by a cart-wheel passing over the head, compressing the cranium; and the patient died almost immediately.

* St. George's Hosp. Mus., 1, 243. Fracture of the petrous position of left temporal bone, through the internal auditory foramen; the fracture also forms one of the boundaries of the preparation. There was a line of fracture transversely across the left middle fossa, reaching from the squamous part of the temporal to the body of the sphenoid; and a smaller fracture passed at right angles to this, through the petrous bone. The lower part of the brain was contused, and there was evidence of meningitis. The patient, a man aged thirty, had fallen downstairs, striking the right side of the head. On admission to the Hospital, half an hour later, he was insensible, and bled from the ear and nose. The pupils were dilated and sluggish. Next day, a copious watery discharge commenced from the left ear, and continued for three days, when death occurred, preceded by delirium and convulsions.

unfrequently occurs. But fracture in this fossa may exist without any extravasation under the ocular conjunctiva, or with only discolouration of the lids; and then the fracture, however extensive, cannot be diagnosed. Extravasation in both these situations may also arise from fracture of the superior maxillary or malar bones; and hæmorrhage from the nose may proceed from fracture of the nasal bones—a broken nose. The appearance of the eyelid is, however, more likely to be mistaken for that of an ordinary "black-eye," as if from contusion of the cheek,—a blow or fall on this part. For, whether produced by cranial fracture, or by contusion only, in both cases there is considerable swelling and purplish discolouration, but with this difference: in the one case, the extravasation, being subcutaneous, looks shaded by the skin; while the other presents the familiar appearance of blood partly in the skin, as the ecchymosis of a bruise. Bleeding from the nose is also often unconnected with any fracture, cranial or nasal; but may arise from a blow, or other cause of contusion and traumatic epistaxis.

The *source* of the blood in any case is uncertain; the fracture must involve some of the large vascular channels lying at the base, and also open up a way for the escape of blood externally. Either or both these effects not being produced, very extensive fracture may exist, undiscovered during life. In fracture involving the *middle* fossa, the middle meningeal artery may be ruptured in any part of its course between the foramen spinosum and the anterior inferior angle of the parietal bone.

The blood is either arterial or venous. Thus, fracture in the anterior fossa, involving the orbital plates of the frontal and extending into the sphenoid bone, will lay open the venous sinuses, or the ophthalmic artery, there situated; and more commonly the former.

Vomiting of blood occurs, when during hæmorrhage the blood has passed down the pharynx into the stomach. Thus, from fracture in the anterior fossa, the blood may trickle back through the nose into the pharynx; or from fracture in the middle fossa, involving the petrous portion of the temporal bone, so as to open the tympanic cavity, blood may find its way through the Eustachian tube into the pharynx; in either case, the blood being swallowed, it is ejected by an occasional vomit. In such cases, also, some of the blood passing into the nares, adds to the nasal hæmorrhage; or bleeding, as if from the *mouth*, occurs; the blood, not swallowed, is spit up, or may even seem to be expectorated. Vomited blood is congealed, of a blackish or brown colour, owing to the action of the gastric juice, and mingled with the contents of the stomach.

The source of *serous fluid* has been disputed. This fluid is regarded by some Surgeons as being merely the serum of the blood, exuding from a clot after extravasation; an opinion advocated by Laugier and Chassaignac. Or, the liquor Cotunnii, secreted from the membrane of the labyrinth, has been credited as the source of escape. But the quantity discharged, sometimes copious and persistent, is irreconcilable with either of these explanations, and the discharge sometimes escaping through the nose, shows the impossibility of its being the liquor Cotunnii. That this serous discharge is really cerebro-spinal fluid, proceeding from the subarachnoid space, would appear to be demonstrated by two kinds of evidence: experimental observation and chemical examination. Thus, in a boy with fractured base of the skull, a small quantity of thin, clear fluid was oozing from his ear; but Mr. Hilton found that a much greater quantity could be made to escape, by artificially inducing congestion of the cerebral circulation. By pressure upon the jugular veins, and with the other hand closing the patient's mouth and nose, so as to stop respiration, in a few moments the fluid began to flow much more rapidly, and half an ounce of it was soon collected. Then again, fracture of the base of the skull after death, in an experiment by M. Robert, immediately produced a discharge of the fluid from the ear, and which became abundant and continuous when the head was hung over the edge of the table. The chemical composition of this discharge has been shown by M. Chatin to be the same as that of the cerebro-spinal fluid; it contains a small quantity of albumen, and a large proportion of chloride of sodium. M. Claude Bernard has also shown that both fluids contain a trace of sugar. The serous discharge may not be coagulable by heat or by nitric acid, owing to the small proportion of albumen present; but some cloudiness, or whitish opacity, may be thus produced. To permit the escape of cerebro-spinal fluid from the subarachnoid space, the arachnoid membrane must have been torn, in conjunction with the fracture, and near the outlet. Thus, as M. Auguste Bérard observed, when this fluid issues from the ear, the reflection of the arachnoid around the auditory nerve, in the internal auditory canal, must have been ruptured; when the nose is the channel of escape, the arachnoid prolongations around the filaments of the olfactory nerves must have been involved, in fracture of the cribriform plate of the ethmoid bone. Both the ear and nose, at the same time, sometimes give issue to this fluid; two cases of this kind having been met with by Malgaigne and Foucard. The pia mater is the source of re-secretion of the fluid discharged.

The *quantity* of this serous discharge is usually abundant; although dropping only or trickling from the ear or nose, it has amounted to twenty ounces in the course of three days; and it often continues for a longer period. Experiments on animals have shown how rapidly the cerebro-spinal fluid is re-secreted. This discharge does not occur only in *young* persons, with basial fracture of the skull, as Robert and others believed; but more often in patients above twenty-five or thirty years of age.

The fall of *temperature* in fracture of the base is sometimes remarkable. In one case, with laceration of the brain, under the care of Mr. Le Gros Clark, the temperature fell to 87·4 degrees in one hour and a half after the injury; this being the lowest temperature observed after any injury, as hitherto recorded. Death ensued in nine hours, the temperature having risen barely to 90 degrees just before death.

Causes, and their Effects.—*Indirect* violence is almost invariably the *only* cause of fractures of the cranium, in its base. A heavy blow, or fall, on the top of the head, is commonly the cause; but a fall, the person alighting on his feet or the buttocks, may be another mode of indirect violence. In either case, the cranium is compressed between two forces, the force of collision on the vertex and that of resistance by the apex of the spinal column; or the latter may be driven inwards, and the top of the head downwards, as in the case of a person falling on his feet.

The production of fracture by indirect violence, at the *opposite* part to the part struck, is designated fracture by *contre-coup* or counter-stroke; the cranium yielding laterally, and giving way at the opposite point of resistance or impulsion. And such was long thought to be the mode in which fracture was produced at the base of the skull. But more recent observations, and particularly Dr. Aran's experiments, have shown that generally these fractures begin, not at the base, but start from the part of the vault struck, and then stretch round into the base. In the front of the vault, such fracture thus leads to fracture of the anterior fossa; in the middle or vertex of the head, to fracture of the middle fossa; and at the back of the head, to fracture of the posterior fossa,—in each situation of fracture, a line leading from the corresponding part of the vault. Fracture of the base of the skull by *contre-coup* would therefore seem to be of very rare occurrence. Guthrie agrees with other modern Surgeons in discrediting the production of counter-fracture. *Direct* violence is, comparatively, very rarely the cause of fracture in any portion of the base. But, at certain parts, the bones are thin and brittle, readily yielding to any force directly applied. Such are the orbits, the nostrils, and the occipital fossæ. Sharp-pointed instruments, as scissors, or a tobacco-pipe, may penetrate the cranial cavity in these situations, and also injure the brain. The condyle of the lower jaw has even been driven into the middle fossa of the base. Occasionally, gunshot injury is a direct cause, as when a pistol is fired into the mouth with suicidal intent.

The accompanying lesions, produced by indirect or direct violence, arise from its extension to the vessels at the base of the brain, to the membranes, and brain, or cranial nerves. Hence, extravasation of blood, the escape of cerebro-spinal fluid, or even of brain-substance, and injury to the nerves emerging from the skull.

Terminations.—(1.) Fracture of the base—the more common form of fractures of the skull—is very frequently fatal. According to the post-mortem examinations made by Mr. John Adams in a large number of cases, it may be inferred that, of all fatal injuries to the skull, those of fractured base constitute about 80 per cent. (2.) In the event of recovery, no union may have taken place, after months or even years; or union partly by dense fibrous tissue with a thin layer of inlaid bone; or bony union, and throughout the whole line of fracture. In some of the latter cases, porous bone has been found heaped up along the sides of the line of fracture, on the inner aspect of the skull, and even blocking up one of the venous sinuses. Authentic cases of recovery are recorded; the patients having lived for a variable period of months or years, and at length dying from other causes, pre-existing fracture of the base of the skull has been verified by examination, as in thirteen such cases collected by Hewett.

The *prognosis* of fractured base of the skull is, as a rule, very unfavourable. This conclusion is sufficiently attested by the statistical results referred to. But a correct interpretation of symptoms—as already explained—will enable the Surgeon to rightly appreciate the grounds of his prognosis. The discharge of cerebro-spinal fluid from the ear or nose is of no serious import in itself; the real source of danger is the accompanying intra-cranial lesions, specially of the membranes of the brain. Fracture of the vault of the skull is occasionally attended with a similar discharge, through a wound of the scalp; yet the fatality has been far less. Of fourteen such cases, gathered from the experience of various Surgeons, eight recovered. But, bearing in mind the pathological significance of a watery discharge in fractured base, the Surgeon may well avail himself of this evidence, in estimating the probability of his patient's recovery. Other symptoms must also be taken into account, as being indicative of severe intra-cranial lesions: hæmorrhage from the ears, nose, or mouth, or into the orbit, from rupture of a meningeal artery, or a venous sinus, with intra-cranial *extravasation;* and also the severity of cerebral concussion or contusion, in relation to its immediate danger, and the consequent *inflammation*, leading to effusion and suppuration.

Treatment.—No operative interference is requisite, or practicable, in fracture of the base. Itself remaining without displacement, the brain-lesions alone assume the whole consequence of the injury. Trephining has, however, been performed successfully, close to the foramen magnum.

Separation of the Sutures, or Diastasis, of the bones of the head, is liable to occur in youth, with or without fracture. This disunion may take place in the vault of the cranium, at the coronal, sagittal, or lambdoidal sutures, or in the cranial base; or sometimes at the junction of epiphyses, as between the occipital and sphenoid bones, or between the petrous and squamous portions of the temporal bone. Such injuries are, to all effects, fractures; and the diagnosis of suture-disunion and fracture at the base of the skull will be impossible in practice; while in the vault, the distinction cannot always be ascertained, unless a scalp-wound admit of more precise examination beneath the integument. But the situation and direction of the disunion, as corresponding to one of the sutures, is always significant of the kind of injury; especially if in connection with a similar swelling of the scalp, arising from venous extravasation through the rupture of a sinus under the suture. Or an interval can be felt between the bones, the more so if the dura mater be lacerated. Diastasis of the cranial bones is usually a fatal injury; owing to the great violence necessary to produce separation of the sutures, the frequent association of fracture, and often of hæmorrhage within the skull, as well as what may appear externally.

Treatment must be conducted in accordance with the rules already laid down with reference to cranial fractures, simple and compound.

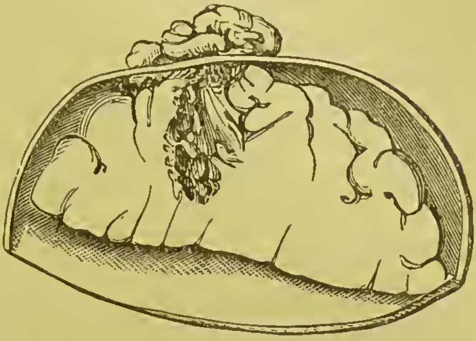
Injuries of the Membranes of the Brain.—*Extravasation of Blood within the Cranium.*—Intra-cranial extravasation, in connection with Injury of the Head, may exist, with or without Fracture of the Skull. But the pathology of extravasation, in either case, is the same—with regard to the situations of effusion, the symptoms, and consequences. These have been already described.

The *Treatment* is that of Compression.

Hernia Cerebri.—Protrusion of the brain-substance is liable to occur in connection with laceration of the brain and its membranes, communicating with compound fracture of the skull. The projecting portion of brain not having any integumental covering is not properly speaking a hernia, and is sometimes designated *fungus* cerebri. (Fig. 605.) It may present itself in any part of the skull; but commonly in some part of the vault, and especially the frontal and parietal regions.

It rarely occurs at the base of the skull; brain-substance then being forced through the ear, nose, or possibly into the pharynx.

FIG. 605.*



The appearances are those of brain-substance, more or less modified; as having a brown colour and bloody character. Nerve-tubules, with the products of inflammation, may be discovered under the microscope. The more obvious appearances, as well as the microscopic characters, will therefore distinguish brain-substance either from a collection of blood protruding under the pia mater, or exuberant granulations from the brain. And, moreover, hernia cerebri is continuous with the brain.

The causes of *hernia cerebri* would seem to be the loss of a portion of bone—hence rare in fracture of the base—and compression of the brain, resulting from inflammation, with the effusion of lymph and pus, or from extravasation of blood, or perchance the presence of a foreign body. The surrounding portion of brain becomes congested, and undergoes yellow softening and disintegration, abscesses form in the hemisphere, and effusion distends the ventricles. The products of inflammation occupy also the cavity of the arachnoid and the sub-arachnoid tissue. Protrusion may take place as the immediate consequence of fracture, but more frequently at a subsequent period,—days or weeks afterwards, when inflammation is established. The symptoms then are those of inflammation of the brain and its membranes, and such as may exist without any protrusion. Age would appear to have some predisposing influence; for protrusion is more often met with at an early period of life. In thirteen cases, ten were under thirty years, eight the youngest, and twenty-seven the oldest; three were from forty to forty-six years, the latter being the oldest patient of all.

The *course* and *terminations* of hernia cerebri are peculiar. Varying in size and shape, according to the aperture in the dura mater through which it had to pass, the tumour gradually increases in bulk, even forming a large mass which may overlap and conceal the wound in the scalp; daily breaking down and sloughing, the tumour is constantly reproduced by further protrusion. Few symptoms, perhaps, of cerebral disturbance accompany this course of destruction; but at length coma supervenes, and death ensues, as the usual issue. Occasionally the tumour sloughing, or shrinking, it wastes away, and cicatrization of the wound follows; the patient recovering without any apparent impairment of his brain-power. This was the result after a very large protrusion; in one remarkable case, published by Mr. Spring, in the "Lond. and Edin. Month. Journ.," 1844, the patient lived eleven years, and after death, the left side of the cranium is said to have been found quite empty. The relative mortality, in fourteen cases, amounted to twelve deaths, and only two recoveries.

Treatment.—As a general rule, hernia cerebri should not be interfered with. Pressure, as by means of a wet lint-compress and bandage, or the removal of the tumour, either by slicing it off, or by ligature, have both been practised; the repressive method of treatment, originally, I believe, by Sir Charles Bell, in this country; while excision of the fungoid protrusion down to the bone, as advocated by Abernethy and Dr. Hill, has more recently been revived by Professor Spence. But pressure is apt to induce coma, and excision is commonly followed by re-protrusion, with more profound coma. A third method of treatment has been proposed: the application of pressure *after* slicing off the protruded portion of brain, thus to avoid the perils of either method separately, and that granulation with cicatrization may close the aperture. Generally, however, the better course is simply to keep the part scrupulously clean, by gently syringing with cold water, and water-dressing; assisted by slight pressure, when the protrusion is small. Any splinter or depressed fragment of bone, or other foreign body, should be extracted, when accessible without undue risk; and particular care must be taken, in such operation, not to injure the dura mater. Antiphlogistic measures must, of course, be combined with local assistance. The *prevention* of hernia cerebri, by compression, has proved far more successful than any curative treatment. Thus, the tendency to protrusion consequent on the removal of any loose portion of bone in comminuted fracture, or after trephining, may be overcome by a well-adjusted pad of lint, and bandage around the head.

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* University Coll. Mus., 131A.

INJURIES OF THE BRAIN.—CONCUSSION.—Literally signifying a shaking, more or less severely, this also is the pathological meaning of the term concussion. Concussion of the brain is a shaking of the brain.

(1.) No lesion of the brain may be discovered after death; and it was formerly held—perhaps is still maintained by some Surgeons—that concussion may prove fatal immediately, without a trace of injury to, or in, the brain-substance. But of late years, this doctrine has been disproved by more careful post-mortem examinations. It is now held by several pathologists, who have specially investigated cerebral affections; that, in concussion, instantaneously fatal, appreciable lesions are to be found in the brain. These lesions may be various; points of extravasated blood, numerously scattered, or circumscribed patches of contusion or bruising, on, or in, the brain-substance. Such is the pathology of concussion of the brain, as shown by Chassaignac, Nélaton, Sanson, Dr. Bright, Blandin, M. Fano, and enforced by the observations of Mr. Prescott Hewett.

(2.) In concussion, not immediately fatal, where life continues for a short time or a few hours, another result is found;—intense congestion of the cerebral vessels and permeating the whole brain-substance; without perhaps any actual lesion.

(3.) Slight concussion, followed by recovery, is probably connected with similar injury to the brain and congestion; varying only in degree, and having no definite proportion to the previous symptoms of concussion. The state of disorganization of the brain is sometimes verified by post-mortem examination, after slight concussion, when death has occurred from some other injury.

These are the only essential lesions in concussion of the brain, as authenticated by more recent observations. The question, in both a positive and negative sense, is obviously of much importance Surgically, and no less so from a Medico-legal point of view.

Symptoms.—The symptoms of concussion of the brain are, essentially, loss of *consciousness*—comprising a suspension of all the functions of the brain, as the direct and immediate effect of the injury. The person is stunned. Three degrees of this state are now commonly recognized—(1.) *Slight* concussion; with momentary loss of sensibility and muscular power; and with depression of the circulation, as denoted by a feeble, but commonly regular and rapid, pulse at the wrist. These symptoms soon pass off; the person comes to again, and proceeds about his business as if nothing had happened, retaining, often, no knowledge of the injury. (2.) *Complete* insensibility; the patient lying motionless, pallid, and cold, the pulse being scarcely perceptible, usually, also, slow and intermittent. The pupils of the eyes vary very much, being contracted or sometimes dilated; or one contracted and the other dilated. The urine and fæces are sometimes voided involuntarily. This state having continued for a period of longer or shorter duration, imperfect insensibility returns; the patient can be roused to answer a question with bewilderment of manner, and then relapses; vomiting supervenes as a symptom of recovery, and the symptoms of concussion gradually pass off in a few hours or days. Headache, confusion, and giddiness remain, or symptoms of intra-cranial inflammation supervene. (3.) *Complete* insensibility, and the *pulse imperceptible.* No reaction follows, and death takes place in a few minutes or a few hours.

Temperature, as affected by injuries of the brain, would seem to afford an important symptom, considering the known physiological influence of the nerve-centres in the production of animal heat. But the fall of temperature is no measure of the amount of brain-lesion. In simple concussion, half an hour after such injury, the temperature has fallen to 93·5 degrees, according to Mr. Le Gros Clark's observations; yet the patient recovered. This reduction of temperature contrasts with the maintenance of heat, under compression of the brain.

The *diagnosis* of concussion and compression of the brain will be considered in connection with the latter state.

The *cause* of cerebral concussion is, of course, external violence, applied directly to the head, as by a blow or fall; or indirectly, by transmission through some other part of the body, as when a person falling from a height alights on his feet.

Consequences.—*Intra-cranial extravasation* of blood is, perhaps, the most immediate occasion of peril, during reaction from cerebral concussion. Thence the symptoms of compression are apt to supervene. *Passive* extravasation, arising generally from injury of the smaller meningeal arteries or of some of the venous sinuses, is characterized by hæmorrhage, recurring from time to time, and a very insidious development of symptoms. Occasional attacks of headache, with the sensation of a rushing sound in the head, are accompanied with dilatation, and sluggish, irregular action of the pupils, and a remarkably slow pulse, which may never have regained its natural frequency, during reaction from concussion; this diminution of the pulse to sixty or even forty beats per minute having a marked relation to the attacks of headache. At length, delirium, convulsions, and coma succeed as symptoms of compression, which soon proves fatal. Superficial and slight extravasation may not give rise to these symptoms, but remain as an exciting cause of cerebral inflammation. *Inflammation* of the brain, or its membranes—of an *acute*, though more commonly of a *chronic* character—is always liable to ensue, even from slight concussion, and, in the latter form of the disorder, after an interval of apparent health. The approach of chronic inflammation may be very insidious, and its results permanent, in the impairment or loss of various cerebral functions. Thus, the memory fails with regard to places or persons, dates, or the recollection of certain words. The special senses become impaired, as by loss of sight, with paralytic falling of the upper eyelid,—ptosis, or squinting; and one or both eyes may be affected. Loss of hearing is sometimes experienced, or various disturbing sounds in the head are heard, and smell or taste may be perverted. Headache, more or less persistent, and sleeplessness or horrible dreams complete the misery of these purely cerebral affections; and paroxysms of maniacal excitement are apt to be induced by any slight indulgence in drink, or by any other occasion of cerebral influence. The muscular strength declines, and the sexual power becomes impaired; while the general health, as depending on innervation, is reduced, and the patient brought to a cachectic, broken state, the very shadow of his former self. Strange to say, the pulse may remain unaffected, or remarkably slow, as if not indicative of any inflammatory mischief in the brain; and this seems to be more particularly observed when the base of the brain is the seat of such morbid change, as declared by the character of the functional symptoms. These results I have had the opportunity of witnessing in several cases, consequent on concussion by railway injury, in which I have been engaged; but it is to be regretted that, in some such cases, their issue cannot be ascertained.

Suppuration, as a consequence of inflammation, will give rise to symptoms of compression. But this takes place at a later period than that of intra-cranial hæmorrhage after concussion, thus aiding the diagnosis of these two causes of compression.

The *prognosis* of cerebral concussion must always have regard to the possibility at least of a fatal result from hæmorrhage or inflammation, leading perhaps to suppuration. On the other hand, recovery is more common; and even after dementia, or deafness, or other loss of special sense, these symptoms may pass off in the course of time, and health be restored.

Treatment.—The pathology of concussion supplies two general indications of treatment; namely, to prevent increasing congestion or the tendency to inflammation, and to give time for the cerebral lesions to recover themselves. Hence, in the *stage of depression*, or insensibility, interference should be little, and judicious—on the one hand, not to increase congestion by blood-letting or other reducing measures; on the other hand, not to hurry on reaction and the tendency to inflammation, by over-stimulation. Stimulants should be administered in proportion to the depression and its continuance, as evinced by the temperature and state of the pulse. But, with complete unconsciousness, there will be the risk of suffocation, in any attempt to excite the act of swallowing; the stomach-pump should then be used to throw in whatever stimulant may be requisite. Other measures may also be employed with advantage; such as a turpentine enema, hot-water cans to the feet and in the axillæ, with perhaps a mustard poultice to the epigastric region. It should be remembered that, while slight depression will be followed by slight reaction, extreme depression will be succeeded by extreme reaction, and this would be aggravated by over-stimulation previously. In this stage of *reaction*, interference should be regulated by its degree, as often bordering on inflammation. An elevated position, with cold lotion to the head, shaved for its application, are the best safeguards. A reduced diet and abstinence from stimulants, coupled with the administration of gentle, watery aperients, will effectually keep the circulation in check. Any tendency to relapse must be watched at the same time, and prevented by recurrence to stimulating treatment.

Absolute rest and the withdrawal of all surrounding circumstances of excitement are imperatively necessary to recovery. A quiet life should then be led for some time; and, if possible, the patient continue under medical supervision. It was justly remarked by Liston —a paraphrase of the maxim of Hippocrates—that "no injury of the head is too trivial to be despised, or too serious to be despaired of."

The treatment of Intra-cranial Extravasation, and of Inflammation and its consequences, as arising from Concussion, will be considered under the general headings,—Compression, and Traumatic Inflammation of the Brain.

Contusion of the Brain.—Bruising and laceration of the brain-substance is associated with contusion, but it may be the most prominent form of lesion. Consisting of spots of extravasated blood and disintegrated brain-substance, these are commonly clustered together in well-marked, circumscribed patches, or occasionally scattered and diffused throughout various parts of the cerebral mass. In the one form of contusion, the grey substance alone is affected; in the other form, the white substance also.

The *situation* of contusion may be either at the spot where the skull was struck—direct contusion, or distant from the seat of violence—contusion by *contre-coup*. The middle and anterior lobes, and especially their under surface, are more frequently bruised than the posterior lobes.

The *symptoms* are unconsciousness more or less complete, without stertorous breathing; tonic spasms of the limbs; and a restless rolling and tossing about in bed. But these symptoms are not immediate, and therefore not necessarily dependent on contusion. This kind of lesion has no symptoms of its own. They have been said to denote "cerebral irritation," as a primary form of cerebral disturbance arising from injury. But the symptoms are not only of subsequent origin, they are also not peculiar. I have seen precisely the same symptoms connected with an abscess in the right posterior lobe of the brain.

Treatment—apart from that for concussion—must have regard to the absorption of extravasated blood, and the prevention of inflammation. Hence the efficacy of cold applications to the head, by means of an ice-bag or evaporating lotion, and the derivative or depletory action of purgatives; these measures being aided sometimes by the general or local abstraction of blood, followed by blistering to the back of the neck. Mercury may be administered in the event of inflammatory symptoms, and opium to quiet delirious excitement; but usually the cachectic condition of chronic inflammation necessitates recourse to a gently stimulating and supporting plan of treatment.

COMPRESSION OF THE BRAIN.—*Symptoms.*—The symptoms of this condition, when fully established, are—insensibility, or coma, as of a profound sleep; the breathing is laborious, slow, and prolonged, accompanied with a stertorous or snoring noise, owing apparently to paralysis of the velum palati, and a puffing blowing of the lips; this sound dying away now and then, it may be succeeded by a sort of catch in the throat, with a start, and relapse into deep snoring; the pupils are dilated, and insensible to light, and the pulse is slow and full. The fæces may pass involuntarily, and the urine be retained, or dribble away. Hemiplegia often occurs, and on the side opposite to the seat of compression. This general state is sometimes varied by attacks of delirium or convulsions. The temperature is maintained, or the fall registered is less than in concussion.

Diagnosis.—The distinction between cerebral compression and *concussion* has been generally determined—mainly by the three symptoms of the breathing, the state of the pupils, and the pulse, to which may be added the relative temperature, as already described with reference to each of these conditions of the brain. In typical or well-marked cases of either condition, it will be possible thus to decide the question of their diagnosis. Much stress has, therefore, been laid on the aforesaid distinctive characters. But in intervening states of cerebral injury, the diagnosis is equivocal. Mr. Hewett affirms that "there is no one symptom, or combination of symptoms, which will enable us to determine positively between concussion and the slighter cases of compression." The coma arising from any cause of cerebral compression may be mistaken for the more or less complete insensibility of *drunkenness*—when the person is said to be "dead drunk," or "stupidly drunk;" an error of diagnosis not so very unfrequent in the casualty-room of Hospitals, and in surgical examination at police-stations. The condition in question may be distinguished partly by the absence of any injury to the head, unless the person have fallen down or been struck on the head, when drunk, as sometimes happens; but the Surgeon should also judge by the smell of the breath, or by any suspicion that the person has been drinking. In the course of a few hours, intoxication will pass off, thus more clearly declaring the nature of the case. *Apoplexy* is another condition which might mislead the Surgeon. But the turgid lividity of the face, and absence of any injury to the head, unless accidental, will be sufficiently distinctive; although the former appearance be associated with a dilated state of the pupils, stertorous breathing, and laborious pulse, as the symptoms of cerebral compression. In either of the cases referred to, drunkenness or apoplexy, the accidental concomitant of head-injury should lead to further examination; for no injury short of fracture with depression can cause any immediate symptoms of compression. Then, indeed, the diagnosis will be impossible; both the co-existing conditions being productive of coma. The insensibility which arises from poisoning by *opium* may be yet another occasion of some doubt as to the nature of the case. But a very distinctive symptom is the contracted, instead of the dilated, state of the pupils; and inquiry should be made respecting the probability of attempted suicide. Here, also, the use of the stomach-pump will both determine the question of diagnosis, and be a preferable mode of treatment to the administration of an emetic; the bare possibility of apoplexy being the cause of compression would render it unadvisable to run the risk of aggravating such an attack by the act of vomiting.

The *causes* of compression agree in their general nature; they are all some source of pressure on the brain. They vary in being—a depressed fracture, or other impacted foreign body; extravasated blood, or a collection of matter, within the cranium; and thus these causes differ widely in their pathological origin and significance. Two such causes may co-exist, as depressed fracture, with extravasation of blood; or all may co-exist, as intra-cranial suppuration, with depressed fracture, and extravasation. Besides causes of traumatic origin, compression may result from apoplexy, or the growth of intra-cranial tumours.

Consequences.—Inflammation of the brain, or its membranes, is equally liable to follow, as from concussion, although the cause of compression will affect the probability of this event. Depressed fracture inevitably leads to inflammation, and intra-cranial suppuration presupposes it. *Death* results from continued compression, in a period varying with the degree of pressure, and the functional importance of the part of the brain affected.

A stationary condition of compression remains occasionally; the patient lying comatose for weeks or months, and recovering consciousness when the compressing cause is removed. A most remarkable case of this result is recorded by Sir A. Cooper; that of a man whose cerebral functions were entirely suspended for a period of thirteen months, by a fall on his head from the yardarm of a vessel, producing a depressed fracture; but on trephining the bone, and thus removing the cause of compression, consciousness returned immediately after this long period of total oblivion—for more than a year.

Treatment.—Obviously, the compressing cause must be removed. This implies a different mode of proceeding according to the particular cause in operation.

The head should be shaved and carefully examined. (1.) *Depressed* fracture will probably necessitate the elevation of the depressed portion of bone, by means of an elevator, or its removal, by trephining. The conditions which justify these operations have been already enumerated in the rules of Treatment pertaining to Fractures of the Cranium. The question of removing a foreign body, as the cause of pressure, may be determined by the same considerations. (2.) Intra-cranial *extravasation of blood* can, generally, be treated without recourse to operative interference. The compressing cause is the same as that of apoplexy. Hence, the extravasation of blood may be arrested and reduced, by cold applications to the head, and by the depletory action of purgatives. No form of purgative seems to act so speedily and impressively on the brain, as a turpentine enema; say, an ounce of turpentine to a pint of gruel, the strength which I am in the habit of ordering. Its beneficial influence should be aided by bottles of hot water to the feet. Cupping on the nape of the neck, or even venesection, may be had recourse to, as indicated by the fullness, hardness, and jerking character of the pulse. It would be highly important to know whether a more powerful derivative action could be established, by means of the suction-apparatus applied to either of the lower limbs; such as was, I believe, originally employed, under other circumstances, by Mr. Jobert. The operation of trephining, to relieve compression from extravasated blood, may be a justifiable procedure, when the situation of the injury, or the existence of a fissured fracture, indicates the probability that a large artery, such as the middle meningeal, is involved, accompanied with compression-symptoms. This rule was sanctioned by the practice of Pott and Brodie, and is supported by Professor Spence's experience. (3.) Intra-cranial *suppuration* is always a question of considerable difficulty as to its existence and situation. This will be considered, and the necessity of having recourse to the operation of trephining, in describing Traumatic Inflammation of the Membranes of the Brain. In the state of coma, from whatever cause, the urine should be drawn off with a catheter, two or three times in the twenty-four hours.

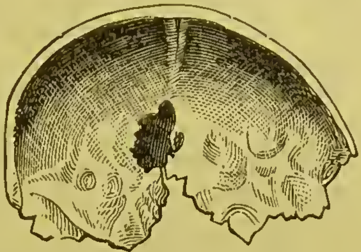
WOUNDS OF THE BRAIN arise from Fracture of the skull, or the simultaneous penetration of some instrument, or other foreign body.

Incised Wound.—The *symptomatic effects* of an incised wound of the brain differ from those of concussion and compression. A great part of the brain of an animal—observes Mayo—may be gently and quietly sliced away with little or no effect, but if ever so small a portion be suddenly crushed, the heart stops directly. Thus also with regard to wounds of the human brain. Cole, in his "Field Practice in India," narrates certain apposite facts: "The English dragoon sword is so blunt, that the strongest man cannot drive it through the head-dress of the Sikh or Afghan; yet the enemy is most often beaten from his horse, and frequently killed by the violence of the shock. Not so, however, with the trenchant blade of the Sikh; this weapon, wielded by a strong man, will cut through any head-piece, and bury itself perhaps in the brain, and yet you find no symptoms of concussion or compression. In the former example, the soldier is effectually disabled, often killed outright; in the latter, although the individual is mortally wounded, he may be able to continue the fight, and even to kill his antagonist, before he falls himself, dead or dying, from his horse." The *seat* of injury is very important; wound of the side or base of the brain is most fatal; and in the upper portion of the brain, the fatality of injury is greater in the anterior part, but diminishes in the middle, and is least in the posterior part.

An incised wound of the skull, as from a sword-cut, may offer one peculiarity with regard to *treatment*. A piece of bone may be detached, and adherent to a flap of integument, owing to the slanting direction of the cut. Necrosis is liable to follow such fracture, and the question will arise as to the desirability of replacing or of removing the fragment. The opinions and practice of the most experienced Surgeons are here divided. Some incline to the opinion of Paré, Hennen, and John Bell, that the slice of bone may be readjusted, with the flap of integument. Other authorities agree with Dupuytren in removing the detached portion of bone, rather than incur the risk of its becoming a foreign body, and thus giving rise to intra-cranial suppuration. Probably, therefore, Guthrie's judicious consideration is better than either absolute rule; namely, to be guided by the more or less firmly adherent connection of the bone-fragment and flap, as to whether it may be replaced, or should be removed. If only the outer table has been sliced off, exposing the diploe, but not opening the cavity of the skull, the useless fragment should certainly be removed, and the flap laid down to unite with the vascular diploe.

Gunshot Wounds—Penetrating and *Perforating*.—Wound of the scalp, with incomplete fracture of the skull, involving only the outer table, may possibly occur as a form of gunshot injury; and the ball, rebounding, falls out of the wound. But when the fracture is complete, and then often depressed, thus penetrating the skull, without, however, forming a counter-opening, the fair inference will be that the brain is wounded, and that the ball has lodged within the cranium. (Fig. 606.) The *symptoms* of brain-injury are insensibility, with or without convulsions; followed by more marked symptoms of compression, as hæmorrhage takes place; or, subsequently, those of cerebral inflammation, leading to serous or purulent effusion, and compression. It is only under notably exceptional circumstances that the Surgeon can be misled in his diagnosis. The ball may not have lodged, but have been withdrawn in removing the cap or other head covering. Then, again, no cerebral symptoms may be produced for some time, even in a period of seven or eight weeks, and not prove fatal until after the lapse of several months; when, by post-mortem examination, the ball has been found encysted, and as a foreign body, therefore, harmless. Remarkable instances of this kind are recorded by Larrey, Hamilton, and Chelius; the longest period during which the person survived having been a year and a half, and the ball weighing seven drachms—lodged within the brain. During the American War of the Rebellion, there were many cases in which patients survived the lodgment of foreign bodies within the skull; but rarely without much cerebral disorder. It is also interesting to note the fact that the mortality of penetrating and perforating gunshot wounds of the head was nearly equal; being 85·5 and 80, or slightly less when the ball passed through, than when it lodged within the cranium.

FIG. 606.*



The *general* mortality of gunshot injuries of the head, chiefly fractures, as gathered from large collections of cases, presented the following high percentage:—

	Per Cent.
British Army in Crimea—Government report by T. P. Matthew ...	73·9
French Army in Crimea—Government report by M. Chenie	74
American War—Government report by G. A. Otis	71·7

Treatment.—Considering the uncertain situation of the ball, and the probability that it has penetrated deeply into the substance of the brain, or that it may have been accidentally withdrawn in removing the head-dress, no attempt should be made to discover the foreign body through the wound. Searching with the probe or the finger may do far more mischief than the presence of the ball would provoke; and the operation of trephining to enlarge the aperture in the cranium would complicate an already sufficiently dangerous lesion. Such procedures have been practised, and indeed with success, but only in a few authentic cases. When the ball lies upon the dura mater, and close to the cranial aperture, this opening may be enlarged so as to allow of extraction. In any case, depressed spiculæ of bone should be raised by the elevator, any overhanging portion of bone removed with Hey's saw, or trephining resorted to. Hæmorrhage must be controlled, if possible. Venous bleeding from one of the sinuses may, perhaps, be arrested by carefully plugging the cranial aperture with a lint-compress; arterial hæmorrhage, as from the middle meningeal, is best controlled for a time, by compressing the vessel with the finger against the inner surface of the skull, or by means of a small wooden plug introduced under the groove of the artery. The results of operative treatment in gunshot fractures of the skull are not encouraging. In the American War, out of 385 cases, where fragments of bone were removed without trephining, 145 of these patients died, showing a mortality of 37·6; and of the remainder which recovered, four-fifths were disabled. After the operation of trephining, there were 95 deaths, 45 cases of partial recovery, and 15 of complete recovery.

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* St. George's Hosp. Mus., 1, 218. Gunshot fracture of frontal bone; passing through the frontal sinus, and carrying away a portion of the orbital plate. From the body of Nicholas B., who was killed in the attempt to assassinate the Emperor of the French, January 14th, 1858. Presented by H. C. Johnson.

Perforating wound of the head presents no peculiarity, except the existence of a second opening, that of exit, about opposite the entrance aperture. The ball having passed through the skull and out again, the question of its extraction will not have to be considered. But the greater damage done to the brain, than by a penetrating wound only, is always a specially dangerous complication. Yet recovery is not beyond hope, although the patient remains permanently disabled by cerebral disorder, various affections of the special senses, or paralysis; fourteen cases of such recovery having been met with in the experience of the American War. It is remarkable, however, what an amount of injury the brain may possibly sustain without any serious consequence or a fatal issue. Perhaps the most notable case of this kind occurred in the experience of Dr. Harlow, an American Surgeon. A man was shot through the head with a tamping iron, which measured three feet and seven inches in length, one inch and a quarter in diameter at its largest end, and weighed thirteen and a quarter pounds; this instrument having entered just in front of the left ramus of the lower jaw, it passed upwards and backwards through the left anterior lobe of the brain, and lacerating the superior longitudinal sinus, with fracture of the frontal and parietal bones and protruding the eyeball, the point lodged at the junction of the coronal and sagittal sutures. Yet the patient survived all this injury, and was alive and well twelve years after the accident. Such a case may somewhat encourage a hopeful prognosis, in an apparently hopeless condition of gunshot injury to the head and brain.

INJURIES OF THE CRANIAL NERVES.—In connection with injury of the Brain or its Membranes, one or more of the cerebral nerves are sometimes involved, and their functions impaired.

The *causes* of such injuries and functional impairment are various, and the same as those of Brain-injury. Thus, one or more of the cerebral nerves may be injured by an *instrument* producing fracture. This mode of lesion, a rather rare occurrence, is liable to happen to certain of these nerves, owing to their more accessible situation; the optic and olfactory nerves being especially liable to be injured by a thrust-wound. The *fracture* itself may implicate one or more of the foramina or canals, through which some of the cerebral nerves emerge from the base of the skull. Certain nerves are more often thus injured than others, owing to the relative frequency of fracture in these situations. The seventh nerve, on account of the frequency of fracture through the petrous portion of the temporal bone, is often injured in this manner; paralysis of the facial or auditory nerve generally denoting fracture of the base of the skull. A portion of broken bone, distant from the foramen or canal of transmission, sometimes occasions injury to a nerve with which it is connected. *Extravasation* of blood at the base of the brain may affect a cerebral nerve, by pressure on the brain at the origin of the nerve, or on the nerve in some part of its course. This mode of paralysis is more temporary; absorption proceeding, it gradually disappears.

Diabetes mellitus may be mentioned as a consequence, occasionally, of cerebral injuries, whether from a blow on the head, or fracture of the skull.

The *Treatment* of these implications of the cerebral nerves is chiefly negative. The natural process of reparation after any such injury and the restoration of function will probably prove more effectual than any blind interference. If the lesion depend on extravasated blood, we know too little of the remedial efficacy of mercurials and blistering for promoting absorption, or of nervine tonics for restoring nerve-function, to regard these measures with much confidence.

TRAUMATIC INFLAMMATION OF THE BRAIN, AND ITS MEMBRANES.—Pathologically considered, Inflammation may affect the Brain or its Membranes, separately; and when of traumatic origin, it may be appropriately named Traumatic Encephalitis and Traumatic Meningitis, respectively. Practically considered, however, these affections are identical, the one giving rise to the other; and both may be described as Inflammation of the Brain. As consequent on Injuries of the Head, this inflammation was accurately described by Pott.

Symptoms.—The symptoms of traumatic intra-cranial inflammation are principally these:—pain in the head, more or less intense, limited to the seat of injury, or spreading thence over the whole head; sleeplessness; contraction of the pupils; intolerance of light and sound, with general feverishness, as denoted by a rapid, bounding, hard pulse and hot, dry skin.

These symptoms, becoming more marked, are succeeded by special disturbance of the brain-functions; delirium or wandering, sickness, restless tossing about, and perhaps convulsions. The aspect of the patient is, indeed, sufficiently characteristic—the excitement and agitation, wild glistening eyes, injected conjunctivæ, flushed face, and throbbing carotids, all indicate the state of the cerebral circulation.

The *second stage* contrasts very much with that of excitement. Drowsiness, stupor and coma, with dilatation of the pupils, a slow, labouring pulse, stertorous breathing, spasmodic twitchings of the muscles, paralysis, and relaxation of the sphincters, together indicate effusion, and compression of the brain. Rigors announce suppuration.

The structural alterations or appearances resulting from inflammation of the brain, and membranes, vary according to the seat and progress of the inflammation. They may be summarily enumerated as follow:—Suppuration in the diploe; lymph or pus of a greenish yellow colour, circumscribed on the outer or cranial surface of the dura mater between it and the bone, and diffused beneath this membrane within the cavity of the arachnoid, and on the pia mater, filling its meshes and prolongations between the convolutions; so that the membrane thus thickened can be removed as a whole from the brain, and looks as if it had been cast in wax. Softening of the brain-substance, abscess in the central part of the brain or cerebellum, and effusion of serum in the ventricles, constitute the alterations peculiar to the brain. The veins are more or less engorged with blood, and the venous sinuses contain coagula.

All these appearances, however, may not co-exist in any one brain, as the results of inflammation.

The *causes* of intra-cranial inflammation, consequent on injury of the head, are the various conditions of injury already described. Thus, scalp-wound, and contusion of the cranium; fractures of the skull, with injury of the membranes of the brain; concussion, contusion, compression, and wounds of the brain;—these several forms of lesion are the starting-points of inflammation.

The train of symptoms above mentioned, supervene at a variable *period* after injury of the head; and this question of time has a tolerably definite relation to the cause of inflammation, thereby indicating the probable source of the symptoms. If dependent upon concussion, the symptoms of intra-cranial inflammation appear at a very early period—perhaps within a few hours; as arising from contusion of the brain-substance, they generally supervene about the fourth or fifth day; whereas, from contusion of the bone, the inflammatory mischief may not appear for a while—many days, or two or three weeks, and then suddenly be declared.

The *prognosis* of intra-cranial inflammation is always precarious, and especially in the second stage, that of effusion or suppuration with coma.

Treatment.—The head should be shaved, and raised in an elevated position; and cold lotions or an ice-bag be applied. Free purgation must then be brought into action, and blood-letting in some form. Local bleeding by means of leeches applied to the temples, or cupping on the nape of the neck, will always be necessary; general blood-letting may be had recourse to according to the severity of the symptoms, and small repeated bleedings are safer and make a more permanent impression on the cerebral circulation than one large blood-letting. Antimonial salines prove useful adjuncts to these depletory and sedative measures, by continuing their influence on the system. Aconite (Fleming's tincture), in small doses of a drop or half a drop, in water, every three hours, is recommended by Mr. Spence, as being safer than antimony, which is apt to induce vomiting. Opium had better not be administered in large or opiate doses; although, in the form of morphia, it may be given to control furious delirium. Bromide of potassium, in large doses, is said to be also very efficacious. Calomel, in small doses, combined with opium, should be pushed to salivation. These measures must be followed up by derivation from the head, by means of blisters applied to the nape of the neck or the head. A blistering-cap is used by the French Surgeons, and dressing the blistered surface with mercury has sometimes been most effectual for restraining effusion in the second stage of inflammation. Ultimately, tonics, especially quinine with the mineral acids, and a generous diet, may be given with great advantage to relieve the lingering headache, and restore the nerve-power and muscular strength.

The state of the viscera, and of the kidneys in particular, should always be examined thoroughly, in relation to both the diagnosis and treatment of inflammation of the brain, arising apparently from any injury of the head.

Chronic Traumatic Encephalitis may be distinguished from the *acute* form of this inflammation, by the insidious development of the symptoms, their less pronounced character, and longer duration. Commencing at variable periods after the head-injury,—within a few days, some weeks, or months—the effects of that injury may have seemingly passed off; whether it was concussion of the brain, or contusion of the skull. Commonly, however, some subdued symptoms of cerebral disturbance remain, continuous from the time of the injury. Occasional headache, of a dull, heavy character, is experienced, with perhaps giddiness, and loss of memory, or some impairment of vision or of hearing; while the patient becomes pale and dispirited, languid and irritable. He looks very ill. Perhaps an epileptic seizure marks the accession of more positive symptoms. Then the attack is similar to that of acute encephalitis; but the stage of delirious excitement is not so violent,—a muttering delirium, with some pain and heat of head, contraction or dilatation of the pupils, or one pupil may be contracted and the other dilated, intolerance of light and sound; these symptoms being succeeded by moaning or screaming, with spasmodic twitchings of the face and limbs, as the patient sinks into a comatose state,—in the stage of compression, resulting from the effusion of serum, lymph, or pus, chiefly within the arachnoid membrane of the brain.

But subacute traumatic encephalitis is not invariably fatal, nor always in this way. The patient may live on, subject to the recurrence of symptoms from any occasional cerebral excitement, and unfitted, therefore, for the business or pleasures of life; losing yet more gradually his mental and physical powers, he becomes a paralytic cripple, until worn out, as a wreck, he dies exhausted. This sad state of vegetating existence will be noticed more particularly in connection with Spinal Meningitis and Myelitis, as the result of concussion of the cord, involving the brain.

The *treatment* of chronic intra-cranial inflammation will consist of the same measures which are appropriate with reference to the acute condition of this disease; but they should be adapted to the subacute character of the symptoms; and the treatment directed rather with the view of preventing their development, than in the hope of removing the products of old-standing arachnitis, or the other structural consequences of inflammation, meningeal or cerebral.

Compression of the brain, indicated by coma, and as depending on *suppuration*, may justify recourse to the operation of trephining. But under what circumstances? Rigors are the surest constitutional sign of suppuration, in connection with any head-injury. Then with coma, and especially with hemiplegia, the only question is the *situation* of the matter. Scalp-wound injury, or contusion of the bone, with perhaps a puffy tumour, will generally indicate the spot. The matter may be located between the bone and dura mater; or *also* beneath this membrane, although very rarely circumscribed within the cavity of the arachnoid,—the dura mater then bulging up tensely into the trephine-aperture, and not presenting any pulsation. An incision must be made and the matter let out.

The operation will, therefore, be effectual in these two *exceptional* conditions—(1) for the evacuation of matter *beneath* the *cranium alone;* (2) or associated with its *circumscribed* formation *beneath* the *dura mater*, in the cavity of the arachnoid.

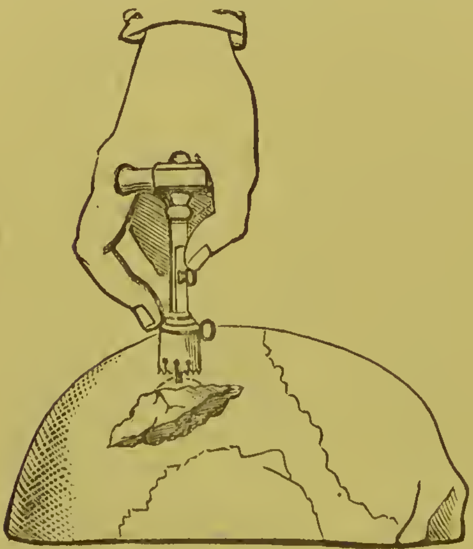
(3.) Abscess in the *Brain* may be superficial or deep. The difficulty will be to determine this question. Having trephined the skull, in consequence of compression-symptoms, one of two conditions may be found. Matter may at once escape through an opening in the dura mater, that membrane having sloughed over a communicating abscess. The difficulty is solved. But if the membrane be entire, without bulging under the trephine-aperture, and with symptoms still of compression, the question again rises as to the situation of the matter, superficially or deeply in the brain. In this doubtful condition, the dura mater has been divided; yet the patient has died with an abscess then discovered, situated just below, under the cortical substance of the brain, and thus provokingly close to the trephine-aperture; or again the abscess, so placed, has burst subsequently, and the patient entirely recovered. The one case—that of leaving the brain intact with a fatal result—happened to Roux; the other—that of natural evacuation of the matter ensuing with recovery—happened to J. L. Petit. The fair inference is this—that if an abscess can be reasonably suspected to be situated *superficially*, as shown by the state of the brain at the part exposed, a slight incision into the brain may be made to discover and evacuate the matter. *Deep*, or central abscess, also, might be interrogated in the same way, and for similar reasons. Dupuytren punctured the brain an inch deep, and at once saved the life of his patient. Dr. Detmold also made deep incisions into the brain, on three different occasions in the same case; the first saved the man from impending death; the latter two, touching the left ventricle, seemed to afford the only chance of recovery. But it is not probable that such deep incisions will be repeated by other Surgeons.

Operation of Trephining.—The conditions of Head-injury, with compression, which render this operation necessary or judicious, have been already fully considered in connection with Fractures, and Compression, as arising from intra-cranial extravasation, or from intra-cranial suppuration, consequent on Traumatic Inflammation. The operation itself remains to be described.

The instruments requisite are a trephine or trepan, small or large-sized, according to the purpose of the operation—either the removal of a portion of bone as the source of compression, or the evacuation of subjacent fluid, extravasated blood, or pus. An elevator and Hey's saw are the only other special instruments.

The head is to be shaved around the seat of operation; the bone, if not already exposed by a scalp-wound, must then be laid bare by a crucial, or T-shaped incision. The trephine, with its centre-pin protruding and fixed into the skull, should be worked from left to right, with a firm, and even-moving, but light-bearing action. (Fig. 607.

Fig. 607.



A fair groove having been thus made, the steadying centre-pin is no longer necessary, and should be withdrawn, lest, passing more deeply, it penetrate the skull first and wound the brain. Complete division of the outer table, and entrance into the diploe, will be plainly shown by the altered character of the *detritus* thrown up by the saw—the dry, white flour of the hard bone being succeeded by bloody and soft grit. A sensation of yielding in entering and passing through the diploe is also very perceptible. It should be remembered that no diploe will be found either in children or the aged. The instrument must now be worked very lightly and cautiously, and withdrawn every turn or two as it approaches the dura mater, in order that the groove may be examined with a probe—a pointed piece of wood or quill—to ascertain the depth and uniformity of penetration around the circular piece of bone. When it seems loosened, an elevator is gently introduced into the groove, and the portion of bone removed.

The particular object of the operation can now be accomplished. Pus or blood will escape or may be evacuated; or a depressed portion of bone can be raised, by insinuating the elevator beneath it and bearing on the finger or the edge of the firm bone as a fulcrum. This implies that in trephining for fracture, the circular piece, or half circle, of bone removed must communicate with the edge of the depressed portion and afford space for its elevation. Sometimes, a projecting portion of bone can be removed with a Hey's saw, or bone-pliers, and space thus made for the introduction of the elevator, without using the trephine. Certain parts of the skull are also ineligible for trephining; namely, over the occipital bone, in the course of the venous sinuses, and over the frontal sinuses. In the latter situation, however, the outer table may be first removed and then the inner. In any situation, loose fragments or *débris* of bone must be carefully picked or brushed out, and the wound gently sponged clean; the scalp is then laid down, retained with a few sutures, if necessary, and a strip of water-dressing applied.

The *after-treatment* consists entirely in measures preventive or curative of inflammation and its consequences.

The *results* of this operation have been very unfavourable. In the Parisian Hospitals, Nélaton reports, of sixteen cases during fifteen years, that all have terminated fatally; this mortality, however, including cases that would have died from the injury of the brain for which the operation was performed.

In the Hospitals of Great Britain—England, Ireland, and Scotland—the mortality, although very high, has been much less; and in those of the United States, the proportion, according to Seuter and Goss, is one recovery to four deaths. The chance of only one to four in favour of life is sufficient to justify the operation under the pressing circumstances for which alone it is now resorted to,—as the sole chance of preserving life.

The more or less successful results of trephining for gunshot fractures of the skull have been already noticed in connection with these injuries.

TUMOURS OF THE HEAD.—(1.) The *Scalp* is liable to be the seat of Cysts or Wens, containing sebaceous matter; or Vascular tumours, as Nævi.

Cysts not unfrequently form on the head, from enlargement of the sebaceous follicles in the scalp. Any such cyst-tumour is then commonly known as a *wen.* Sometimes, however, it may be a new formation. The tumour is usually round, or somewhat conical, varying in size from a marble to a horse-chestnut or larger, and of soft or more solid consistence and elastic character, according to the thickness of the cyst-wall and the density of the contained sebaceous matter. The tumour is painless, or tender only when handled or injured. The cyst-wall, having a fibro-cellular structure lined with epithelium, may be quite thin and membranous, or thick, and forming a fibrous capsule, when the follicle has long undergone hypertrophy. But the cellular connection of the capsule with the scalp is generally so loose, that it can be readily detached from its bed. The sebaceous contents vary in colour and consistence. In a recent wen, the contained matter has a whitish or yellowish colour, and is soft, like clotted cream; in a wen of longer duration, this matter is greyish and firmer, resembling putty, or friable and sometimes stratified in concentric layers. Or the contents may have a mixed character, partly soft and yellowish, partly dry, and of a greenish, brown, or black colour. These different appearances of the sebaceous matter correspond to degenerative changes; a caseous transformation, and discolouration produced perhaps by changes in the hæmatosine of blood-corpuscles which have become intermixed, by pressure or other slight injury to which the scalp-tumour has been exposed. Under the microscope, the sebaceous matter is seen to consist chiefly of cholesterine, associated with blood-particles, epithelial scales, and perhaps abortive hairs.

Wens are often multiple, giving to the head a singularly nodulated and unsightly appearance; more conspicuous when the person is bald.

The *diagnosis* of an ordinary scalp-wen is simple; for although, in a thin-walled cyst, the consistence may resemble a subcutaneous *fatty tumour*, or lipoma, the irregular or somewhat lobulated surface and even the doughy character of this form of tumour are distinctive. While an *abscess* is distinguished by its more fluid or fluctuating, rather than elastic character, the tumour is less movable—owing to surrounding infiltration; and when threatening to point, the throbbing, painful swelling will further declare its nature. A thick-walled sebaceous cyst is unlike both these kinds of tumour. Sometimes, a black point may be found on the summit of the cyst, and through this—which is the obstructed duct of the follicle—some sebaceous matter may be squeezed, and thus the diagnosis will be determined.

In the ordinary *course* of a scalp-wen, the tumour remains simply a harmless disfigurement. But it is ever liable to inflame and ulcerate, the integument over the cyst acquiring a bluish-red colour, the skin becomes thinner and cracks, and an oozing discharge scabs the surface; when this is removed or falls off, a small fretting ulcer remains, which enlarging slowly, at length evacuates the contents of the cyst, leaving a circular cavity, with a thickened margin, and discharging a thin fœtid fluid. In consequence of inflammatory infiltration around the cyst, the tumour loses its movable character, and, getting set in the scalp, resembles a more solid tumour with the integument over it inflamed. Rarely, the cyst itself is loosened by suppuration, and expelled; the cavity closing up by granulation, and cicatrization completing this natural mode of cure. But scalp-wens are generally found in persons who are past middle age, and whose health is naturally weak or prematurely broken; this constitutional state tending to induce ulceration, and to maintain the obstinate indisposition of the ulcer to heal.

The *treatment* of a scalp-wen will depend upon circumstances. When small and quiescent, it may be left alone, unless it be desirable to remove it for the sake of appearance. But even then the liability to erysipelas supervening on any wound of the scalp, and in an unhealthy part, will restrain the Surgeon from unnecessary interfercnce; especially in a patient whose constitutional condition is unfavourable, when any operative procedure should be at least postponed until that is improved by medicinal and dietetic measures. On the other hand, in such persons there is always the greater tendency to ulceration, and a tedious cure. When the tumour is of larger size and troublesome, it should be removed. This may be readily done, by laying open the cyst through its whole diameter with a scalpel, pressing out the sebaceous contents, and then seizing the wall with a stout forceps, enucleate the cyst from its cellular bed. A thin-walled cyst cannot be thus shelled out; but the membranous capsule may be detached with the handle of the scalpel, and torn out with the forceps. No portion of the scalp should ever be removed; when apparently redundant, it will contract; and even when unsound, it will recover itself. The lips of the incision may be brought together by narrow strips of common adhesive plaster, or closed by two or three points of suture. A lint-compress will promote the union of the surfaces of the cavity; and the whole dressing may be retained by a head-bandage. If, as sometimes happens, the lips of the wound refuse to unite—especially when the integument is unsound—the cavity reopens, and must be dressed from the bottom with lint soaked in carbolic solution. After entire removal of the cyst, the tumour never returns.

Another method of treatment consists in puncturing the cyst, or introducing a probe through the black-pointed obstructed duct of the follicle, in order to squeeze out the sebaceous matter; then, the opening being made of sufficient size, the interior of the cyst is freely cauterized with nitrate of silver, or a small seton passed in, thus to induce inflammatory adhesion of the cavity. But more often a prolonged suppurative discharge and open sore results; the cyst-cavity having become an indolent and unhealthy ulcer.

Congenital sebaceous cysts are sometimes met with in the scalp, resembling ordinary wens in this situation, but distinguished by the tumour often lying in contact with the dura mater; the cranium being perforated, either in consequence of continued pressure or from congenitally incomplete development.

In infancy or childhood, the chief question of *diagnosis* is to distinguish between a wen of the scalp, and one which, through an opening in the skull, lies upon the dura mater; and which may also be an *encephalocele* or hernial protrusion of the brain. This distinction will be drawn, principally, by observing whether any such tumour enlarges and subsides somewhat under the movements of respiration, and is rendered fuller by the expiratory acts of coughing or crying; and by the effect of compression in producing any disturbance of the cerebral functions. Sometimes, the margin of the cranial aperture can be felt with the tip of the finger; but it may be impossible to thus determine whether the opening is complete, or a depression only from destruction, or absence of the outer table of the skull. *Nævus* will resemble an encephalocele, or a sebaceous cyst with cranial perforation; the tumour being affected by the respiratory movements, and when seated in the *cranium*, as a pulsatile tumour of bone, some cerebral disturbance may be elicited by compression. Purplish discolouration of the scalp-integument may also present a closer resemblance to encephalocele than to a perforating cyst-tumour. The more or less complete disappearance of the tumour under pressure is the chief mark of a vascular or nævoid growth.

The question of *treatment* turns upon that of diagnosis. It will be obviously perilous to remove a congenital sebaceous cyst, which may be in close relation with the brain, unless the Surgeon be driven to thus interfere by the urgency of cerebral symptoms.

(2.) The *Cranium* may be the seat of various tumours, the principal forms of which are four in number: ivory exostosis, situated perhaps near the orbit, or on other parts of the cranium; fibrous or fibro-cystic tumour; myeloid tumour; and cancer. Their leading symptoms, diagnosis, and treatment are conveniently exhibited in the following tabular view, by Mr. T. Holmes.

Tumours of the Skull.	*Leading Symptoms.*	*Diagnosis.*	*Treatment.*
Exostosis.	A small and very hard tumour, growing very slowly, unaccompanied by any symptoms except in very rare cases, when it grows from both tables, or in the orbit and displacing the globe.	From diseased enlargements of the bone; by the presence of symptoms in the latter, and by their less distinct and circumscribed outline.	Operative interference is seldom justifiable.
Fibrous or fibro cystic.	A slowly growing tumour, more soft than exostosis, and more liable to affect the brain by growing inwards.	From exostosis, as above; from cancerous tumours, by its less rapid growth, and by the other usual diagnostic marks; from fibrous tumour of the dura mater, the diagnosis is obvious before perforation of the skull has taken place, but impossible afterwards.	No interference is permissible. Life may be prolonged many years, even after the tumour has produced pressure on the brain and cerebral symptoms.
Myeloid.	These same observations apply to the symptoms, diagnosis, and treatment of these forms of tumour; with the exception that their course is more rapid, and that in all other respects they bear a closer resemblance to cancerous disease.		
Cancer.	Circumscribed pain in the head; soon followed by the appearance of a tumour, or by softening and pulsation at the seat of pain. The tumour grows rapidly, and soon produces pressure on the brain. Malignant cachexia is usually well marked. The skull is usually thickened around the tumour.	From innocent tumour; by its more rapid course and by the constitutional symptoms. From hernia cerebri, following absorption of the skull (very rare); by the greater violence of the pulsation, the absence of the movement of the brain dependent on respiration, and the less uniform consistence of the tumour. From vascular tumour (or aneurism by anastomosis); by the cerebral symptoms induced by pressure, and by the signs of cancer.	No treatment is possible.

(3.) *The Brain, and its Membranes.*—(*a.*) *Fungous Tumours of the Dura Mater.*—Originally described by Louis under this general heading, different kinds of tumour are comprised; some being innocent and some malignant. They all, however, agree in certain particulars, and can hardly be diagnosed from each other, but must be carefully distinguished from other forms of tumour. They are non-congenital, and thus distinguished from nævi and from hernial tumours; and they perforate the skull, which distinguishes them from aneurism by anastomosis and from ordinary solid tumours. At an early period, a general diagnostic sign is the presence of a thin crackling parchment-like layer of bone over the tumour.

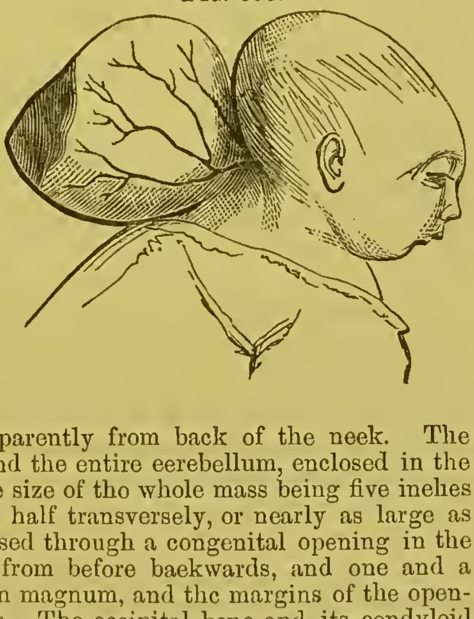
The penetration of any tumour through the skull is made known by pulsation communicated from the subjacent brain, and by the cerebral symptoms which pressure on the surface produces; sometimes, also, the margin of the opening in the skull can be felt. The tumour is seldom very prominent, often hardly raised above the surface of the skull, but feels like a soft pulsating spot in the bone. Such pulsating tumours may be single or multiple. According to the activity of their pulsation, some diagnosis may be made between these tumours. Active pulsation will probably denote soft cancer; pulsation communicated from the brain may indicate fibrous or fibro-cellular tumour. Some of these perforating tumours are not entirely of intra-cranial origin, but spring also from the diploe of the bone; and then the diagnostic character of pulsation becomes very equivocal.

The *course* and *termination* of these tumours depend entirely on their nature. The innocent tumours are assuredly not necessarily fatal; a fibrous tumour of the skull and dura mater has been known to produce occasional symptoms of compression for more than fifteen years, and yet the patient died at a tolerably advanced age, and of another disease unconnected with that of the skull.

No *treatment* of any operative kind for the removal of these tumours will be warrantable or effectual.

(*b.*) *Congenital Hernial Tumours of the Brain and Membranes.*—Encephalocele and Meningocele are hernial tumours, respectively, of the brain and its membranes, or of the membranes alone, the protruding bag being filled with sub-arachnoid fluid; and both kinds of tumour result from congenital deficiency of the bone in some part of the skull, generally the occiput. (Fig. 608.) The tumour thus formed

FIG. 608.*



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* Encephalocele from occiput, and apparently from back of the neck. The tumour contained a portion of the brain, and the entire cerebellum, enclosed in the dura mater and arachnoid membranes; the size of the whole mass being five inches and a quarter in length, and three and a half transversely, or nearly as large as the child's head. This protrusion had passed through a congenital opening in the occipital bone, two inches and a quarter from before backwards, and one and a quarter across, continuous with the foramen magnum, and the margins of the opening corresponding with the lateral sinuses. The occipital bone and its condyloid articulations were otherwise perfect; but immediately above the commencement of the spinal canal there was an expanded osseous cavity, and on each side the jugular foramen containing its vein and nerves. "Med.-Chir. Trans." vol. xxxix. (John Z. Laurence.)

varies in size from a pea to a protrusion exceeding the child's head; it is soft, rounded, and bluish in colour where covered by thin skin. Such a tumour resembles nævus, in its congenital formation, colour, and increasing size when the child cries; and it is also difficult to distinguish from a congenital sebaceous cyst in the scalp, with perforation of the cranium. The subject of this malformation is usually still-born or dies early; occasionally the child lives to an adult age.

Treatment by any operative interference will scarcely be justifiable. But—as with spina bifida—when the protrusion is rapidly increasing and threatening to burst, a puncture, followed by evenly adjusted support, may be resorted to. In one case, an encephalocele was sliced off, and the patient survived.

HYDROCEPHALUS, and PARACENTESIS CAPITIS.—Sometimes the Surgeon is called upon to puncture the head, to relieve symptoms of compression in an otherwise fatal case of hydrocephalus, in childhood. This operative procedure consists in introducing a very fine trocar and canula perpendicularly through the anterior fontanelle, away from the longitudinal sinus. Two or three ounces of the serous fluid having been allowed to escape, the puncture is closed with a piece of lint, and the temporary support of a bandage to the head will be advisable. The operation may have to be repeated occasionally, at perhaps intervals of two or three weeks.

ORGANS OF SPECIAL SENSE, AND THEIR APPENDAGES.

CHAPTER XLIII.*

OPHTHALMIC SURGERY; OR INJURIES AND DISEASES OF THE EYE, AND ITS APPENDAGES.

A CONDENSED view of the Injuries and Diseases of the Eye will meet the requirements of the Student and the Practioner, in the special department of Ophthalmic Surgery, as part of a general work on Surgery.

INJURIES.

WOUNDS.—(1.) The *Eyebrows* and *Eyelids* are liable to the injuries of other soft parts.

Incised wounds or cuts are of common occurrence, whether by accident or violence. The mobility of these parts, subject to the twitching action of the corrugator supercilii and levator palpebræ muscles, disturbs the process of adhesion and renders cicatrization irregular, with proportionate disfigurement and probable eversion or inversion of the lid.

The consequences of any such wound may be serious, although the eye itself escape direct injury; loss or impairment of vision, where the blow has been violent, resulting from some lesion of the nerve centres, or of the optic tract, chiasma, or nerve.

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* Revised and enlarged by Henry Power, F.R.C.S.

The *treatment* of the wound is simple. The lips of integument must be accurately adjusted, and retained by two or three points of fine suture, as the extent of incision may require. Water-dressing and rest will then probably prevent inflammation, and promote union.

(2.) The *eye* itself is also liable to the lesions of other soft parts; but, being lodged within the cavity of the orbit, it more frequently escapes injury.

Wounds are, however, met with occasionally. An *incised* wound or clean linear cut may be caused by a piece of glass or the edge of some cutting instrument. Both these occasions of incision I have seen. In the latter case, the end of a sharp chisel suddenly broke off and flew into the eye of a man who was using the instrument, dividing the cornea and lodging deeply in the globe of the eye. It was withdrawn by Mr. Murphy, senior house surgeon at the Hospital. The fragment measured five-eighths of an inch in length, three-eighths in breadth; and it weighed thirty-nine grains. Subsequently I extirpated the eyeball on account of cerebral symptoms, and threatened sympathetic affection of the other eye. The patient made an excellent recovery, and that eye remained unaffected. In another case also of similar accident, I removed the injured eyeball, and with an equally good result.

Prolapsus of the iris may arise from an incised wound of the cornea; the aqueous humour escaping, and the iris protruding through the wound.

Penetrating wounds of the eye are of a lacerative character, being produced, in most cases, by some blunt-pointed instrument, which, not unfrequently passing beyond the eye or to one side of it, may enter the orbit also, and the brain; fracture and wound of the brain thus most seriously complicating the injury, or proving fatal. Such wounds have been occasioned by a fork or steel pen, by a thrust with the point of an umbrella, or a spine of wood abutting from a tree and meeting the eye of a person who was running through a wood. An explosion of gunpowder may throw grains of powder in the eye, or grit by the force of explosion; or a stray shot from a gun may enter the eye. Both the eyes of Mr. Fawcett, M.P., were accidentally destroyed by a shot which centrally penetrated the cornea of either eye. In the diabolical outrage at Clerkenwell by the firing of a barrel of petroleum and gunpowder, both eyes of a little boy—one of the victims under my care at the Royal Free Hospital—were destroyed, and his mother lost her left eye entirely in like manner.

The *consequences* of any *penetrating* wound are almost always formidable, unless the instrument have been clean and sharp, and have only divided the cornea, or penetrated through the sclerotic coat into the vitreous humour, without damaging the lens. In general, especially if the lens be injured, the eye is lost from the violent inflammation, often terminating in suppuration or atrophy, that follows the blow; and even where the immediate effects are less serious, the adhesions that are apt to form between the iris and the cornea or lens, constituting *anterior* and *posterior synechiæ*, occasion great impairment of vision, or may lead to sympathetic ophthalmia of the opposite eye. A penetrating fracture of the orbit and wound of the brain have obviously most serious consequences. In one case recorded by Nélaton, a singular result followed. The cavernous sinus and internal carotid artery on the opposite side were wounded by the thrust of an umbrella into the orbit; an arterio-venous aneurism formed, protruding the eyeball, and fatal hæmorrhage ensued.

Treatment.—Nothing, of course, can be done to a wound of the eyeball to facilitate repair of the lesion itself; but the consequences of inflammation with regard to this organ and the brain, must be promptly met. Perfect rest in a darkened room, with local bloodletting, blistering, and the administration of calomel and opium, constitute the principal preventive measures. Antimony or anything likely to produce sickness must be avoided, and also active purgation; the efforts of straining in vomiting or defecation affect the eye unfavourably, and peril prolapsus of the iris. Those cases of cuts and lacerations which take place through the margin of the cornea and implicate the adjoining part of the ciliary region, are by far the most likely to lead to sympathetic ophthalmia. And it may be stated as a general rule that in such injuries the eye should be at once removed. If this proceeding is demurred to by the patient or by the relatives of the patient, the treatment above recommended should be adopted, but at the same time an earnest warning should be given that the removal of the injured eye will be rendered imperative if, in the course of a few days or weeks, the opposite eye become inflamed or the vision impaired.

In many instances, when the cornea has been cut through, the iris protrudes to a greater or less extent; and when this has occurred, and the patient is seen shortly afterwards, an attempt may be made to reduce the prolapsed part with a probe or curette, aided by a drop or two of solution of atropine or of eserine, according to the position of the wound,—the former being used if the inner or pupillary margin of the iris is engaged; the latter, if the peripheral portion be prolapsed. These means constitute the best precaution against the occurrence or the recurrence of prolapsus, by insuring dilatation or contraction of the pupil. Strangulation of an unreduced prolapsus soon supervenes, rendering reduction impossible. If prolapsus of the iris cannot be reduced, whether in the first instance or owing to strangulation, the protruding portion may be snipped off with fine curved scissors, to prevent any irritation of the eye by its presence; and cicatrization rapidly takes place, leaving a somewhat opaque scar. Any application of nitrate of silver is unnecessary or injurious.

Opacity of the lens or its capsule, forming traumatic cataract, may eventually necessitate an operation for its extraction.

Complete disorganization of the eyeball, by or in consequence of a penetrating wound, will probably necessitate extirpation of the organ; as in the two cases already noticed. But, in another case of such wound from a stab with a fork, penetrating the cornea, abscess formed in the anterior chamber; this I opened by a crescentic flap-incision with a triangular-bladed Beer's knife, as for cataract, and the eyeball remained without affecting the other organ.

Contusion.—Blows on the eye produce contusion; restricted to the eyebrows and lids, with the ordinary appearance of "black-eye," or involving the eyeball, with peculiar appearances.

Black-eye consists of an extravasation of blood in the subcutaneous cellular tissue of the eyelids; exhibiting the usual discolouration of ecchymosis, and undergoing various shades of colour from black to green and yellow, as it disappears. The subconjunctival texture is likewise infiltrated. *Emphysema* of the lids sometimes results from severe blows on the eye, and is attributable to fracture of the bones of the nose, and laceration of the mucous membrane, permitting air to penetrate into the subcutaneous connective tissue. Concussion of the retina may accompany this palpebral lesion, followed by temporary or permanent loss of sight. In such cases ophthalmoscopic examination will sometimes demonstrate patches of ecchymosis on the retina.

Contusion of the *eyeball* presents the appearances of blood extravasated into the chambers of the eye, and especially into the anterior chamber, partly or wholly concealing the iris and pupil. Extravasation may here also undergo absorption, in a period varying from a week or two to some months, according to the suppression of inflammation.

Rupture of the eyeball, produced by a blow, is always a very serious injury; comprising escape of the aqueous humour, with perhaps detachment of the iris, or dislocation of the crystalline lens forwards into the anterior chamber or backwards into the vitreous humour. Sometimes this humour escapes, and the globe of the eye collapses. Intense inflammation follows any rupturing injury.

The *treatment* of contusion varies with the damage done. An ordinary black-eye may be left to itself, or the disfigurement chased away by arnica lotion. The mouse's-back bruise produced by the pounding fist of a prize-fighter has, I believe, been removed by puncturing and sucking out the blood. Contusion involving the eyeball must be promptly met by measures preventive of inflammation, as by the application of cold compresses, with moderate pressure, rest in a darkened room, purging, etc.; while rupture of the ball usually requires some kind of operative interference. Thus, an artificial pupil may have to be made; or, if much vitreous humour have escaped or hæmorrhage taken place, if the lens be rendered opaque, or the retina detached, the immediate removal of the eye should be recommended.

Foreign Bodies.—Various kinds of foreign bodies are apt to enter the eye; a grain of sand or particle of brick or mortar, lime, flint, shot, or other matter to which the eye may perchance be exposed by occupation, amusement, accident, or in the event of malicious intent. Such bodies lodge commonly in the conjunctiva, and under either lid; occasionally they are impacted in the cornea, or penetrate deeply into the eye.

The exposed part of the eye can readily be inspected; the inside of the lower lid and lower part of the globe, simply by depressing the lid with the finger, so as to evert the lid, while the patient is desired to look up; or the upper lid and corresponding part of the globe can be examined by raising the lid as the person looks downwards. To completely inspect this lid, it is necessary to evert it; a little procedure easily accomplished by laying a probe across the globe of the eye at the back of the lid, then taking the eyelashes between the finger and thumb and turning the lid upwards over the probe, thus exposing the palpebral cartilage. Sometimes, however, the eye is shut forcibly and screwed up, by the pain of irritation, or timidity of the patient; and eversion cannot be at once effected.

Treatment.—Removal of a foreign body from the conjunctiva can generally be accomplished by a light touch with a probe or fine scoop, the hand resting steadily on the cheek; or a camel's-hair brush may be employed more effectually, and the eye swept round to remove more than one particle. In the Welsh iron-mining districts, the workmen have a knack of skilfully licking out a particle of iron from the eye; a nasty mode of performing a nice ophthalmic operation, but it answers well, and the tongue-brush is always ready for any emergency. Powder, of any kind, must be syringed out with water; or lime may be neutralized and removed by thus applying weak vinegar-and-water, and subsequently instilling a few drops of oil two or three times a day.

Abrasion of the conjunctiva sometimes occurs, without the presence of a foreign body, as by the scratch of a finger-nail; and any such injury will occasion more pain, if less irritation, than a rough particle in the eye. A drop of castor oil is, according to Mr. Bowman's experience, the most soothing application; but a small pad of cotton wool should, in addition, be placed on the closed eyelid, and a bandage passed round the head, so that the eye may be kept at rest. The abraded epithelium is usually restored in the course of a day or two.

Impacted and penetrating foreign bodies are to be extracted as soon as possible. Sportsmen engaged in shooting frequently receive shots in the eye, and many eyes are annually lost in this way. The fact of the entrance of the shot is in all instances a subject of anxious inquiry. Accurate conclusions may sometimes be drawn from a careful consideration of the position of the head of the patient in regard to the point from whence the shot was fired, his distance from it, and the strength of the charge. As a rule, the shot may be held to be lodged in the eye when there is a distinct hole in the cornea or sclerotic, through which a probe can be passed,—when the iris is torn and the lens is hazy or cataractous. In such cases, if the patient will consent, removal of the eye is the best treatment, as it can never again become a useful organ, whilst the presence of the shot is exceedingly likely to cause irritation, followed by sympathetic inflammation in the opposite eye. In some rare cases, however, shots have remained for a long time imbedded in the eye, without being productive of any harm. And the risk of sympathetic ophthalmia is much less if the shot has passed quite through the globe, and lodged in the connective tissue and fat of the orbit.

In the slighter forms of injury, inflammation generally subsides after removal of the cause, but it should be subdued if it continue; remembering, however, that after the removal of any small particle of matter from the eye, the sensation of its presence remains for some time, with continued redness of the conjunctiva and lachrymation. This sensation is sympathetic, and practically misleading.

DISEASES.

DISEASES OF THE EYELIDS.—(1.) *Hordeolum*, or *Stye*.—A minute boil, beginning at the edge of the lid, as a small, red, hard swelling, accompanied with itching and a sense of stiffness. The whole lid perhaps becomes involved, and the eye closed. Matter forms and discharges from the summit of the boil, a small slough of cellular texture escapes, and the red swelling subsides and disappears. Sometimes this furuncular inflammation remains indolent, without suppuration.

Weak and scrofulous children are most subject to this affection; adults far less commonly.

Treatment consists in warm fomentations or poultices, until pointing occurs; with tonics, attention to the bowels and diet. Indolent stye may be touched with nitrate of silver.

(2.) *Abscess in the Meibomian follicles.*—An obstructed follicle, containing retained secretion, forms a minute, solid granule, which irritates the eye. Abscess of the follicle follows. The lower lid is commonly affected.

The *treatment* is simply a puncture and evulsion of the small nodule by means of a scoop; then the irritation subsides.

(3.) *Ciliary Blepharitis*, or *Ophthalmia tarsi.*—Inflammation at the roots of the eyelashes, forming minute pustules, which, discharging, encrusts and mats the eyelashes together, and gums the eyelids during sleep. The hairs become misplaced and inverted, constituting the state named *trichiasis;* or the hair-bulbs are destroyed, and the hairs shed, leaving the margins of the lids ulcerated and raw, or rounded into a smooth, red, shining cicatrix, having neither hairs nor Meibomian orifices. Superadded to this state, the puncta may be obliterated, the tears running over the cheeks, causing irritability and blinking of the lids, and thus constituting the condition properly named *lippitudo.*

Treatment.—Any accumulation of crusts must be carefully washed off night and morning, in order to remove this source of irritation, and to make applications to the minute sores at the roots of the hairs. For this twofold purpose, also, they may be kept closely cut with scissors, providing they are not inverted. Stimulating ointments, such as the diluted ung. hydrarg. nitratis, should then be applied by a small camel's-hair brush. Lotions are useful adjuncts—*e.g.*, the carbonate of soda or the acetate of lead, from two to four grains in the ounce of distilled water. With *ulceration*, the hairs should be plucked out. *Lippitudo* may be much relieved by slitting up the canaliculi. The general treatment throughout must be tonic, and have special regard to the state of the digestive organs. Attention should be paid to the refraction of the eye, and, when required, appropriate glasses should be ordered.

(4.) *Trichiasis* is an irregular growth of the eyelashes, the general form of the eyelid remaining unaltered, and the ciliary misplacement arising from any cause. A single hair, or several, may be affected, with proportionate irritation and a constantly watery state of the eye.

The *treatment* is simple, and often effectual. The offending hair or hairs must be removed; a single hair by forceps, with a slow, steady pull so as not to snap it and leave the root; or several hairs may be removed by dissecting out the small portion of lid, external to the tarsal cartilage, in which their roots are implanted, and uniting the wound with a suture. Where only two or three cilia are wrongly directed, an ingenious little operation has been suggested to rectify this displacement. This consists in doubling a long hair, and threading a needle with the loop. The point of the needle is then made to penetrate the edge of the lid at the base of the hair, and to emerge through the skin. As the loop follows, it is cast over the offending cilium, which is thus made to pursue the track of the needle, and assume a new direction in which it no longer comes into contact with the surface of the cornea.

(5.) *Entropion.*—An *inversion* of the lids as distinguished from trichiasis, which is a displacement, chiefly by ingrowth, of the eyelashes. But the two conditions are frequently associated. Both occasion the same symptoms of irritation of the eye, and are aggravated by their concurrence. Entropion arises from various causes, and presents, therefore, certain special and incidental symptoms. Spasm of the orbicularis palpebrarum muscle, in the irritable ophthalmia of children, is the simplest form of entropion, and as affecting the lower lid; a similar spasmodic inversion happens in the relaxed lower lid of old persons. Chronic inflammation of the palpebral conjunctiva occasions a far more severe and obstinate entropion, the upper tarsal cartilage curving upon itself, until the whole range of eyelashes turns backwards against the globe. Contraction of the conjunctiva, consequent on prolonged stimulation by nitrate of silver or sulphate of copper, or cicatrization following injury from acids, caustic alkalies, or burns, are occasional causes.

Treatment must of course have reference to any cause in operation. Various procedures have been devised to counteract the resulting inversion. *Excision* of an elliptical portion of the skin of the lid, together with the subjacent fasciculus of muscle, and then uniting the edges of the wound with fine sutures, may effect a cure in a flaccid lid, subject to spasmodic inversion. Care should be taken lest, by removing too large a portion of skin, an opposite state, eversion of the lid, be produced. M. Arlt has suggested a plan which gives in some instances excellent results. The eyelid is firmly fixed by a blepharospath, which prevents bleeding. A very sharp Gräfe's linear cataract-knife is then made to penetrate the margin of the lid, between the point of emergence of the cilia and the orifices of the Meibomian glands, to the depth of about one-sixth of an inch; the point of the knife is then thrust through the skin, and is carefully conducted from one end of the lid to the other. (Fig. 609.) By this means the roots of the cilia, with a portion of the free border of the lid, are completely detached, except at the two extremities of the cut. A crescentic portion of the skin of the lid above the upper incision is now removed, and, as is shown in Fig. 610, the upper border of the piece containing the roots of the cilia is attached by sutures to the upper border of the second incision. An *extreme* degree of inversion, by incurvation of the tarsal cartilage, may be overcome by Mr. Streatfeild's expedient. The skin of the lid having been dissected up, a long, narrow, wedge-shaped slice is excised from the tarsal cartilage, forming a groove extending the whole length of the tarsus. Excurvation is thus produced, and the flap of skin being replaced is united with sutures.‡

FIG. 609.*

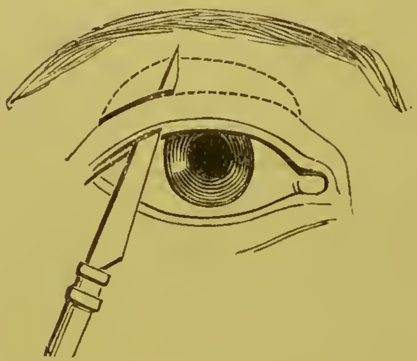
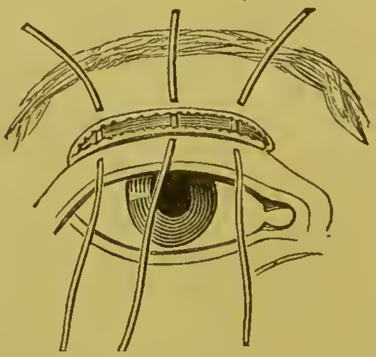


FIG. 610.†



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* This drawing shows the first stage in the method of treating entropion recommended by Arlt.

† This drawing shows the second stage in Arlt's method of treating entropion.

‡ For another method see *Lancet*, April 14, 1877.

Trichiasis may require removal of the eyelashes, with the portion of tarsal margin containing their roots.

(6.) *Ectropion—eversion* of the lids—is the opposite condition to entropion. The appearance of the inner surface of the lids—the conjunctiva—red, swollen, and discharging, will be readily recognized. Eversion arises either from chronic thickening of the palpebral conjunctiva, which presents granular excrescences—the state known as *granular lids;* or, from contraction of the skin, by cicatrization, as after a burn on the cheek.

Treatment, here also, must have reference to the cause in operation, and to the resulting deformity. Thickening of the conjunctiva may be reduced by the moderate application of nitrate of silver, or diluted ung. hydrarg. nitratis, diluted ung. hydr. nitrico-oxydi, or diluted ung. zinci oxydi. This failing, a portion of the palpebral conjunctiva must be excised, that the lid may be restored to position by contraction; and it may be necessary to remove also a wedge-shaped piece of the tarsal cartilage. Or a method devised by Dieffenbach may prove more effectual; an incision through the lid down to the conjunctiva, which is drawn out so that the lid resumes its right direction to the globe, when the projecting fold is snipped off, and the incision closed. Another method suggested by Dieffenbach, when the ectropion is due to the cicatrix of an abscess or burn, consists in making a triangular incision with the base upwards, enclosing the cicatrix, which is entirely removed; the two sides of the upper horizontal cut are prolonged to such a distance as may seem requisite, and the skin freely separated from the subjacent tissues. (Fig. 611.) The eyelid is then placed in its proper position, and the edges of the wound carefully brought together by sutures, as shown in Fig. 612. In other instances, again, it may become requisite to perform a plastic operation. One amongst many methods of performing such a procedure is shown in the accompanying figures. (Figs. 613, 614.) In all instances, however, the shape of the flaps must be varied with the position and extent of the cicatrix, and with an intelligent conception of the object of the operation. It may be accepted as a general rule that as small a portion as possible of the original skin should be removed, or the patient may be left in a worse

FIG. 611.*

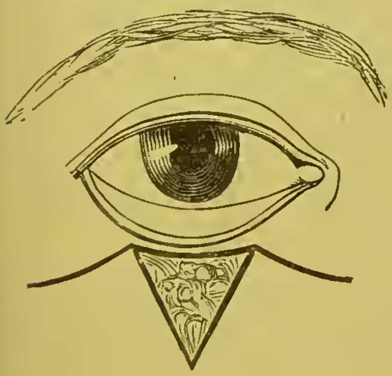
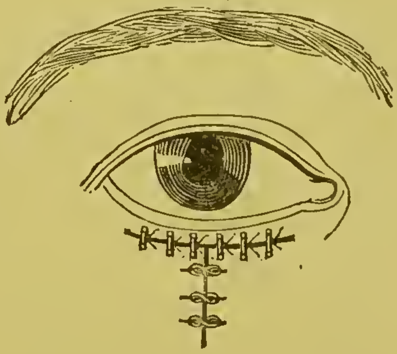


FIG. 612.†



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* The figure shows the incisions required in Dieffenbach's method of treating ectropion resulting from cicatrix.

† This figure shows the appearance of the wound in Dieffenbach's operation for ectropion, after the sutures have been tied.

condition than he was before the operation; and it may further be borne in mind that, as the operation is primarily undertaken for the cure of a deformity, the effects of the incisions about to be made should be carefully considered before they are made, and the greatest care should be taken in the accurate adaptation of the flaps. An everting cicatrix of the eyelid may lastly be remedied by the transplantation or transposition of a portion of adjoining healthy skin.

FIG. 613.*

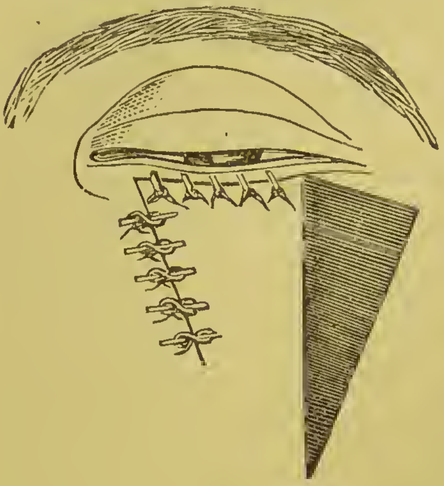
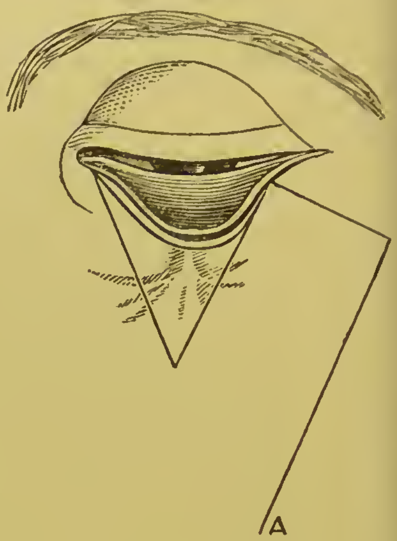


FIG. 614.†



(7.) *Epicanthus.*—A crescentic fold of redundant skin at the inner corner of each eye, partly or wholly concealing the caruncle. Being associated with a depression of the nasal bones, the face has a laterally stretched, Chinese expression. This disappears somewhat, as, in after life, the bridge of the nose rises, and carries up the fold of integument.

The only cure is by pinching up a vertical fold of skin between the eyebrows, removing it, and uniting with sutures.

(8.) *Union of the Lids—Anchyloblepharon.*—This state may be partial, and resulting from ulceration, or complete and congenital.

Division of the junction, and separation of the lids, will sometimes prove successful.

(9.) *Union of the Lids to the Globe—Symblepharon.*—This state also may be more or less complete, but it is, I believe, always of traumatic origin; the adhesions resulting from destruction of the opposed surfaces of conjunctiva, as by quick-lime injury or a burn. One of the worst cases I ever saw was owing to an accidental thrust in the eye with a hot poker.

Division of the adhesions and separation of the surfaces is the only mode of cure. But union is apt to return; to obviate which, Mr. Walton divides the band vertically, through its entire thickness, and brings the edges of each side together by sutures.

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* This figure shows the incision that may be made to rectify an ectropion resulting from a cicatrix.

† This figure shows the mode in which the flap, limited by the incisions seen in Fig. 613, may be brought up and fixed by sutures to rectify an ectropion resulting from a cicatrix.

Deficiency of the eyelids may occur from wounds or cicatricial contraction. But the loss of substance will sometimes admit of repair by plastic operations; a suitable portion of skin being transplanted from an adjoining part, either by twisting round or gliding forwards the requisite integumental covering. Thus, for the repair of the upper eyelid, a flap may be borrowed from the forehead; for the lower eyelid, from the cheek.

(10.) *Hare Eye—Lagophthalmos*—is an open state of the eye, arising from various causes. Structural conditions, as the contraction of a cicatrix, resemble ectropion; and are amenable to the same treatment. Paralysis of the orbicularis muscle, from various conditions affecting the facial trunk of the seventh nerve or portio dura, allows the levator palpebræ to act unopposed, and thus keeps the eye open. Exposure to cold may have this paralyzing effect temporarily; or it may depend on some more centric and permanent cause, as a tumour in the course of the nerve, disease of the petrous portion of the temporal bone transmitting the nerve, or upon congestion of the brain.

The *treatment* will be guided entirely by the apparent cause. Temporary paralysis may be relieved by derivation—a blister behind the ear.

(11.) *Ptosis* is a dropping of the upper lid, owing to paralysis of the third, or motor-oculi, nerve; the eye itself is abducted, the pupil dilated and fixed, and vision somewhat impaired with crossed diplopia. The eyelid is smooth and unwrinkled, and the forehead furrowed by the frequent action of the occipito-frontalis muscle, in attempting thus to raise the lid. Headache, giddiness, and other cerebral symptoms, may denote congestion of the brain as the cause; or ptosis may be symptomatic of general debility.

Congenital ptosis sometimes occurs, and then, probably, the levator palpebræ muscle is altogether wanting.

The *treatment* of ordinary ptosis must be directed to the removal of cerebral congestion, by derivation and purgatives, followed by stimulants and tonics; or, when depending on general debility, the latter kind of remedial measures will be alone appropriate. Ptosis, otherwise incurable, may perhaps be remedied by an operative procedure—removal of a portion of skin from near the eyebrow, in order that the lid may be subject to the elevating action of the occipito-frontalis muscle. This should not be had recourse to when double vision would be established by the abducted state of the eye.

(12.) *Spasmodic twitching* of the orbicularis muscle is accompanied with a visible quivering of the skin of the eyelid, known as *live-blood.* Either lid may be affected, commonly the lower one. It usually results from or accompanies states of nervous debility, but appears to be symptomatic of intestinal irritation, especially by ascarides.

Treatment will chiefly consist in the administration of purgatives and tonics.

(13.) *Hysterical Affection of the Eyelids* is characterized by sudden and acute paroxysms of pain in the lids and eyes, aggravated by slight pressure, and occurring in girls or young women otherwise subject to hysteria. I have not met with any notice of this affection in books, but I have seen a well-marked case in a young lady, who also suddenly —in two days—lost the sight of her right eye, and so completely that she could only discern the glimmering of a strong light with that eye.

The organ itself was not diseased in any way; although carefully examined with the ophthalmoscope, no change could be detected. Menstruation was healthy.

Chloroform seemed to me likely to prove the readiest means of subduing the paroxysms in this case; and having administered it on one such occasion which I happened to witness, the pain ceased, but returned as the anæsthetic influence passed off; on renewing it, the pain again subsided, and the patient slept the remainder of the night. Next morning, she was as well as ever; the amaurosis remaining.

(14.) *Morbid Growths or Tumours of the Lids.*—The same tumours as in other parts of the body are liable to form in the eyelids, only on a smaller scale. Thus may be enumerated, more particularly, cysts, enlarged sebaceous follicles, warts, nævi, and cancer, including the epithelial variety. The pathology of these growths, as affecting the lids, scarcely requires any special notice, and particulars of this kind will be found in works on Ophthalmic Surgery.

The *treatment* is not peculiar. Growths situated in the eyelids must be removed, either by careful dissection, or by fine ligature. A nævus having formed in the upper eyelid, about the size of a large pea, I passed a thread underneath the skin, around the base, by means of a fine curved needle; and the skin being thus preserved, no ectropion followed.

Lice—phthirius or *crab-lice*, as distinct from pediculi of the scalp—sometimes lodge about the roots of the eyelashes. They occasion an intolerable itching, and the lashes present a powdery appearance, clogging the roots with yellowish-grey and brown crusts, so as to resemble ophthalmia tarsi. But the movements of the insects may be detected.

White precipitate ointment—ung. hydrarg. ammonio-chloridi—smeared into the roots of the eyelashes, will soon destroy the enemy.

Diseases of the Lachrymal Apparatus.—This appendage to the Eye consists of the lachrymal gland, situated within the outer angle of the orbit, which secretes the tears to moisten the eye; the puncta and canaliculi, situated at the inner angle of the eye, which drain away any superfluous fluid into the adjoining lachrymal sac, as a temporary receptacle; and of the lachrymo-nasal canal or duct, which conveys such fluid into the lower meatus of the nose.

(1.) *The Lachrymal Gland.*—This small almond-shaped body is rarely the seat of injury or disease. Sheltered, in a recess, within the outer angular process of the frontal bone, the lachrymal gland is not exposed to violence; and it seldom participates in the inflammation of neighbouring tissues, nor seems subject to disease commencing in its structure. Inflammation, acute and chronic, and growths, simple and malignant, are described by some writers, especially foreign authors.

The *ducts* of the lachrymal gland are liable to become obstructed, forming a small cyst-like tumour in the upper eyelid—*dacryops*—which is plainly seen when the lid is everted. Puncture of the cyst is apt to be followed by a minute fistulous aperture in the skin, through which the secretion continually distils. This *dacryops fistulosus* may be remedied, by passing a thread through the opening and thickness of the lid, bringing it out at the conjunctival surface. A knot having been made at one end, this end is drawn into the fistula, and, by continued traction of the other end, the knot is made to ulcerate its way through the conjunctival surface. The tears thus being diverted, the fistulous aperture may be closed by paring and uniting its edges.

Tumour of the gland presents a lobulated enlargement at the outer angle of the orbit. Extirpation is the only remedy. This operation may also have to be performed to overcome the inconvenience of an overflow of tears, when the puncta and canaliculi, at the inner angle of the eye, have been wholly destroyed by an extensive burn. In three such cases, Mr. Dixon has extirpated the gland; and these are the only instances of this operation which have fallen within his experience. The gland has been removed with the eye; and sometimes it has been involved in the disease of this organ, but more frequently found in a healthy state.

Care must be taken not to confound a syphilitic node with a swelling of the lachrymal gland. In the former disease the free use of iodide of potassium will usually speedily effect a cure.

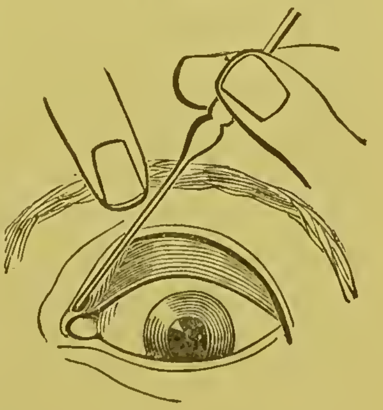
(2.) *Lachrymal Obstructions.*—The puncta, canaliculi, the lachrymal sac, and the nasal duct are severally liable to become the seat of obstruction; and far more frequently than the excretory ducts of the gland itself. Thickening of the delicate lining mucous membrane would seem to be the cause of obstruction, in each of these portions of the lachrymal excretory apparatus.

Epiphora is an overflow of tears, and may therefore be symptomatic of any lachrymal obstruction on the nasal side. Obstruction of the *puncta* or of the *canaliculi* will be attended with a complete overflow; none of the secretion finding its way into the sac. Obstruction of the *nasal duct*, by stricture, necessitates an accumulation of the tears and mucus, within the sac; forming a swelling—*mucocele*—just below the inner angle of the eye. The distended sac becomes inflamed and suppurates, forming an abscess; and this at length discharges itself through an opening in the skin, constituting *fistula lachrymalis.*

The appearances of these transitional states are too obvious to need description. The fistulous opening is generally beset with fungous granulations, owing to the constant irritation of the trickling discharge. Further destruction of the surrounding skin, or even of the bony casement of the sac, sometimes ensues. Or, the fistulous opening contracts to a small pin-hole aperture, resembling one of the puncta.

Treatment.—The cause of obstruction must be removed, and for this purpose its seat must be reached. Inflammatory thickening of the membrane lining the sac and nasal canal may be lessened by small oval blisters applied over the sac. Astringent lotions of alum or tannin dropped into the eye, pass through the puncta to the thickened membrane. Acute inflammation should be met by warm fomentations and water-dressing; and when abscess has supervened, an incision must be made into the sac and the pus evacuated. The general health should be attended to, according to its condition in the course of the case. Tonics will generally be indicated.

FIG. 615.*



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* Shows the mode of passing a probe through the canaliculus into the nasal sac.

Operative removal of the obstruction.—The proceeding which will be appropriate, varies with the seat of obstruction.

The *puncta* may be contracted; and then Mr. Bowman recommends that one of them should be cut across close to the obstruction, and the *canaliculus* slit up on a fine probe, as in Fig. 615. When the *canaliculus* is the seat of contraction, the sac may be punctured below the tendo-oculi, and the canal slit up on a fine probe run into it from the sac up to the point of obstruction. The tendo-oculi is easily found as it crosses the sac, by pressing with the point of the finger on the inner side, and thus putting the tendon on the stretch. *Displacement* of the puncta, resulting from thickening of the conjunctiva by chronic inflammation, is to be remedied in another way. Mr. Bowman slits up the canal from the punctum to a spot where it can catch the tears before it can overflow the margin of the lid. After either of these operations, the probe must be introduced for several days to prevent closure of the wound.

The *lachrymal sac* and *nasal duct* are, perhaps, more commonly the seat of obstruction, by thickening of the lining membrane forming stricture. The last-mentioned operation—that of slitting up a canaliculus from the punctum, with a probe-pointed canaliculus knife (Figs. 516, 617)—affords a ready entrance to this portion of the lachrymal excretory apparatus. The tarsus being put on the stretch, a probe of sufficient thickness is introduced—best by the Surgeon standing *behind* the patient—and passed along the opened canaliculus, until its extremity strikes against the inner wall of the sac. Then, keeping it there, the probe is raised to a vertical position, and carefully slid downwards to the seat of stricture; observing to take the direction of the canal, somewhat backwards and outwards. The instrument is thus passed into the nasal cavity, and on withdrawing it, the contents of the sac may be pressed down into the nose, or after any temporary swelling has been reduced by fomentation. This proceeding must be repeated from time to time, until a cure is effected; just as in the treatment of stricture of the urethra by gradual dilatation. There is this, however, important difference—that, as the lachrymo-nasal duct is ensheathed in a bony canal, thickening of its lining mucous membrane takes place concentrically; any undue violence, therefore, would only increase the inflammatory thickening, instead of lessening the stricture.

FIG. 616.*

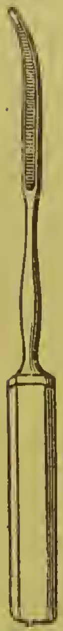
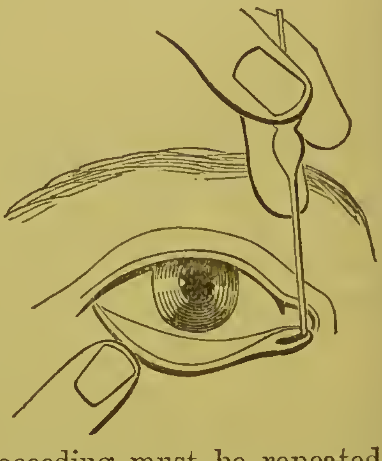


FIG. 617.†



The introduction of a *style* through the sac, after slitting up the canaliculus, and allowing it to remain for a short time in the nasal canal, is another mode of treatment.

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* Weber's probe-pointed knife, for slitting up the canaliculus.

† The canaliculus is here shown after division, with a probe inserted into the nasal duct.

Dacryoliths.—Concretions, by deposition of the earthy salts of the tears, sometimes form in the canaliculi or in the sac. This occasion of obstruction is also attended with the constant overflow of tears, swelling in the situation of obstruction, inflammation, and perhaps suppuration.

The introduction of a probe into the canaliculus, or thence into the sac, will detect the presence of the concretion; which must then be removed by an incision, a scoop being used to extract the foreign body.

A *detached eyelash* sometimes intrudes into one of the canaliculi; its point protruding irritates the caruncle and semilunar fold; or it may almost escape detection.

Removal of the hair with a fine forceps will at once terminate this inconvenience.

Polypus has been known to form in the lachrymal sac; giving rise to a tumour, or swelling of soft consistence, and varying in size from a pea to a filbert.

Any such growth may be removed with fine scissors or ligature, the sac having been laid open.

DISEASES OF THE CONJUNCTIVA.—(1.) CONJUNCTIVITIS, OR OPHTHALMIA. —Inflammation of the conjunctiva, originating in this membrane, presents certain characteristic appearances; and whereby it can be distinguished from inflammation of the sclerotic coat of the eye itself, or sclerotitis—a very important diagnosis.

Symptoms.—Conjunctivitis is denoted by bright scarlet redness of the conjunctiva; most apparent on the inner surface of the lids and junction around the sclerotic coat of the eye, but shading off as it approaches the cornea; and this redness consists of a network of the conjunctival vessels, which are plainly seen owing to their superficial position, tortuosity, open arrangement, and large size, as well as by their mobility. On the other hand, the redness of sclerotitis is most marked around the edge of the cornea, in the form of a dusky pink zone—sclerotic zone—shading off as it disappears backwards beneath the fibrous expansion of the recti muscles; and this zonular redness is simply a uniform tint without visible anastomoses, the sclerotic vessels being closely set together and of smaller size. Sclerotic redness is characteristic of several forms of disease in the deep-seated tissues of the eye; and therefore the twofold distinctive features of its situation and the vascularity, as compared with that of conjunctivitis, should be carefully noted by the student and observed in practice. The additional symptoms of conjunctival inflammation are smarting, heat, weight, and stiffness in the lids, and as the disease advances, a sensation as if a grain of sand were rubbing between them and the globe. There is a more or less abundant flow of tears or lachrymation, particularly on exposure of the eye, and some intolerance of light.

The *causes* of this simple and typical form of the disease may be—slight local irritation, as by an inverted eyelash or other small foreign body in the eye, or exposure to cold and damp; disorder of the digestive organs and general debility. March winds and dyspepsia, co-operating, frequently give rise to ordinary conjunctivitis.

Treatment.—The removal of any source of local irritation must, of course, be primarily attended to. Remedial measures should then have reference to the state of the inflammation, and of the general health. Topical bleeding, by a leech or two, or cupping to the temple, will rarely be necessary; derivation by blistering, and weak astringent lotions or eye-washes, usually proving sufficient to reduce the vascularity. The liquor plumbi diacetatis, fifteen minims to the ounce of distilled water, forms a useful collyrium; though it should never be used when there is any abrasion of the surface of the cornea, lest a white deposit should take place. Warm fomentations, and especially warm poppy fomentations, are often very agreeable and soothing to the patient. Spermaceti ointment may be smeared on the eyelashes at bed-time, when there is any tendency to gumming of the lids during sleep. The general treatment should not be of a lowering character; active purgation will rarely be requisite, but regulation of the bowels and the correction of any error of diet constitute the plan of treatment. Thus, a stomachic mixture, consisting of bicarbonate of potash, the diluted hydrocyanic acid, with the tinctures of gentian and rhubarb, may often be prescribed with great benefit; combined with plain nutritious food. Tonics will often have to be resorted to; quinine and iron or the mineral acids.

Varieties of conjunctivitis are worthy of *differential* notice.

(*a.*) *Catarrhal* Ophthalmia.—A peculiar characteristic of this variety—observes Mr. Dixon—is the existence of numerous red blotches at different parts of the network of vessels, produced by some of these having given way and allowed their blood to become extravasated. The extravasations vary much in size; some being as small as a pin's head, whilst others almost equal the breadth of the cornea. Mucous secretion, little at first, may afterwards become so profuse as to resemble another variety of Ophthalmia,—the *purulent*. Sometimes, the sclerotic is involved, as denoted by a pink zone at the margin of the cornea; and, the subconjunctival cellular tissue getting infiltrated, the conjunctival membrane is raised over the sclerotic into a bleb containing serous fluid, an appearance which ceases abruptly at the margin of the cornea. This elevated condition of the inflamed conjunctiva is named *Chemosis*. The upper eyelid also frequently becomes œdematous, and overhangs the lower lid,—in this mixed state of conjunctival and sclerotic inflammation.

Treatment.—The unmixed state of inflammation, when the conjunctiva alone is affected, and without constitutional disturbance, requires no further treatment than the local application of nitrate of silver in solution,—two grains to the ounce of distilled water, which should be dropped into the eye, twice or thrice a day. Previously to using the drops, the conjunctiva should be cleansed with warm water. Eye-drops, in this and other ophthalmic affections, are introduced by just separating the lids with the thumb and forefinger of the left hand, and then inserting the drop by a camel's-hair brush, or by means of a pipette, between the lids at the outer angle of the eye, so that the fluid shall pass, in the course of the tears, over the globe. This being continued for a week, it may then be used once a day, for perhaps a week longer, when the cure will be complete. If the sclerotic and perhaps the cornea have become implicated, nitrate of silver must be omitted, and the inflammation treated as when these textures of the eye are alone affected.

(*b.*) *Phlyctenular* or *Pustular* Ophthalmia is characterized by little, reddish, aphthous-like elevations on the conjunctiva, having whitish centres, but not containing pus; and each surrounded by a plexus of blood-vessels. They are sometimes seated on the edge of the cornea. This variety of ophthalmia frequently occurs, particularly in children.

The *treatment* should consist in clearing the bowels with some mild laxative or brisk purgative, according to the age and strength of the patient; the administration of quinine, or quinine and iron, or of cod-liver oil; and the application to the under surface of the upper lid of a small portion of the so-called Pagenstecher's ointment, composed of two or four grains of the binoxide of mercury in one ounce of spermaceti ointment.

(*c.*) *Purulent Ophthalmia.*—In this variety of the disease, the *cornea* is very liable to become involved; thus constituting its distinctive peculiarity. Three *sub*-varieties are recognized; purulent ophthalmia, as it occurs in *adults*, in *new-born infants*, and that of *gonorrhœal* origin. But they all agree in implicating the cornea, and also often resemble each other so closely, as not to be distinguished otherwise than by their respective origins.

Purulent ophthalmia, in a well-marked state, presents the following appearances. The lids are dull red or purple, swollen and œdematous; when drawn apart, thick yellow purulent secretion oozes out from the conjunctiva, and, if allowed to dry, forms a crust, concealing the eyelashes. The patient cannot open his heavy eyelids, and is pale and depressed, the more so with the belief that he is blind. Chemosis exists to such a degree as to overlap the cornea, and ulceration or sloughing of the cornea supervenes. The former commences at the extreme margin of the cornea, underneath the overlapping chemosis, and might therefore escape observation; extending as a deep crescentic groove, perforation takes place, and prolapsus of the iris, which appears as a small dark nodule at the bottom of the ulcer, with some deformity of the pupil. Sometimes the ulcerative groove, extending around the cornea, isolates its central portion, which bulges as a whitish or opaque shield; or, becoming thinned, it is darkened by mixed fibres of the protruding iris. Sloughing of the cornea is preceded by yellowish opacity and dulness of the surface, the cornea having the appearance of wash-leather; softening and shreddy disintegration of the cornea ensues, the whole iris bulges with it, and, with fibrous exudation, constitutes a *staphyloma*.

Purulent ophthalmia is communicable by contact with the purulent secretion,—it is a contagious disease. It is most common in hot climates—hence named Egyptian Ophthalmia; and I often saw the disease at Constantinople, during the Crimean War. It also occurs most frequently in this country during the hottest months—July and August, particularly during the prevalence of an east wind. Dust irritating the conjunctiva is a predisposing cause.

Treatment.—Arrest of the purulent inflammation, in time to prevent ulceration or sloughing of the cornea, is the grand indication. Local measures consist in the frequent use of astringent lotions; nitrate of silver, three or four grains to the ounce of water; or alum, in the proportion of eight or ten grains to the ounce. These eye-washes may be applied by sponging or syringing, three or four times a day. Ulceration itself can sometimes be arrested by touching the spot with a fine pencil of nitrate of silver, or a probe coated with the fused salt; the eye being immediately afterwards freely washed with a weak solution of common salt.

Chemosis having formed, destruction of the cornea is threatened, apparently by strangulation of the surrounding sclerotic vessels. Tension must, therefore, be at once relieved. This is accomplished by incising the swollen conjunctiva, from the cornea to its palpebral reflection, on either side of the eye; care being taken, in using a small curved bistoury, not to wound the sclerotic coat. Warm fomentations will aid the bleeding and discharge. The general treatment equally has in view the liability to ulcerative destruction of the eye, especially in a weak, debilitated subject, whose power of assimilation has already failed. Tonics and a nutritious diet are, therefore, far more appropriate than any depletory measures. Opiates may be combined with advantage to allay the irritability of weakness.

Purulent Ophthalmia, in *new-born infants.—Ophthalmia neonatorum* commences within a few days of birth, usually about the third day. The symptoms much resemble those of the disease in adults. The tumid overhanging upper lids are a conspicuous feature; and on the slightest pressure, a pea-like drop of thick, yellow pus starts out from the inner canthus. Ulceration and sloughing of the cornea are equally imminent.

The *cause* of this disease in new-born infants is the contact of some morbid discharge from the mother, at the time of birth. Possibly, this discharge may be of a gonorrhœal character; but leucorrhœa would seem to be another source of contagion.

Treatment is precisely similar to that of the disease in adults. All antiphlogistic measures must be carefully avoided; a moderate strength of astringent eye-washes, diligently used, with tonics, as a few drops of Battley's liquor cinchonæ, and a free suckling of the child, constitute the plan of treatment whereby destruction of the eye may be prevented.

(*d.*) *Gonorrhœal* Ophthalmia is essentially the same in its symptoms as those of ordinary purulent ophthalmia; but it differs in being far more severe and destructive, and in its origin. It is caused by the application of gonorrhœal matter from the urethra to the eye. Both eyes are often affected, and usually at an interval of a few days; the eye attacked last generally suffers least. The presence of gonorrhœal discharge from the penis will throw light on the diagnosis; and a patient having violent conjunctivitis, but who denies having contracted any urethral discharge, should always be examined.

The *treatment* is substantially that of ordinary purulent ophthalmia, as already directed. But the measures indicated must be even more promptly applied,—more preventive. With every precaution, ulceration frequently happens; still the treatment should be pursued in the hope of retaining a small portion of the cornea transparent, for the purpose of making an artificial pupil eventually and thus preserving even partial vision. This will be a greater boon if both eyes are affected; lest the filming opacity darken into total blindness.

(*e.*) *Scrofulous* Ophthalmia.—This is essentially a disease of the *cornea*, the conjunctiva being only secondarily involved. One or more small whitish elevations—phlyctænulæ, or perhaps pin-head ulcers—beset the cornea, which is otherwise hazy, with a long plexus of vessels running from the corneal margin to the morbid spot. This leash of vessels is quite diagnostic of the disease; there is some zonular redness in the sclerotic, immediately around the cornea, but no general vascularity of the conjunctiva. Great intolerance of light—*photophobia*—is another characteristic, with violent spasmodic contraction of the orbicular muscle,—closing the eyes forcibly, when any attempt is made to examine them. This symptom is often out of all proportion to the extent of corneal disease; co-existing probably with only one phlyctænula or ulcer and its leash of vessels, on almost a clean cornea. Lachrymation is profuse, the tears gushing out whenever the lids are the least separated; and there is often some excoriation of their margins. The patient, habitually avoiding the light, acquires a sort of frowning and downcast look, and prominent brow, resulting from constant action of the corrugator muscles. Add to these appearances, the concomitant marks of scrofula in other parts of the body, and the picture of scrofulous ophthalmia is complete. It chiefly affects children, but may be seen in adults.

Treatment.—The general health is more important than the ophthalmic condition. A regimen—the very reverse probably of that which the child has undergone—must be instituted for the improvement of nutrition, and thereby arrest the disintegrative process going on in the cornea. Air, exercise, and plain nutritious food; with iron, quinine, and cod-liver oil, as medicinal measures; comprise the elements of the anti-scrofulous course of treatment. The bowels will have to be well regulated, as part of the treatment of the scrofulous constitution, and in consequence of the constipating influence of iron. Further particulars respecting the most eligible preparations of the medicinal agents referred to, were noticed in the general treatment of SCROFULA. Of topical applications, Pagenstecher's ointment, containing four grains of the binoxide of mercury to one ounce of lard, or a weak astringent lotion of alum, two or three grains to the ounce of water, are perhaps the most efficacious; and warm poppy-head fomentations or the vapour of laudanum will most effectually relieve the distressing intolerance of light. A green shade should be worn to shield the eyes. A small blister may be applied to the temple, and repeated in a week or ten days; but there is little need of derivation. Spermaceti, or dilute citrine ointment, may be smeared along the edges of the lids at bed-time, in the advanced stage of the disease. Of local applications *not* to be used, Mr. Dixon especially denounces the nitrate of silver, and lead lotion whenever an ulcer exists—the carbonate of lead being precipitated and forming an insoluble white deposit in the cicatrix.

In some obstinate cases the internal administration of belladonna will be found, extremely serviceable, the dose being from one-sixth to one-quarter of a grain of the extract in combination with a little extract of hyoscyamus and grey powder. Occasionally a seton inserted into the temple is effective. In other instances, again, the outer surface of the lids may be painted over three or four times with a brush dipped in tincture of iodine, each coat being allowed to dry before another is applied; and in very refractory patients, the application of a douche of cold water to the back of the neck sometimes proves a ready cure.

A *Nebula* or opacity of the cornea, resulting from cicatrization, remains more or less permanently after a prolonged attack of scrofulous ophthalmia; but this result gradually wears out in after years, and at length a faint trace only may indicate the site of the cicatrix.

Granular Conjunctiva is a serious consequence of purulent ophthalmia in any form, or of a long-continued course of irritant applications. A thickened and rough state of the conjunctiva is thus produced; and particularly of the palpebral conjunctiva, which, when examined, appears villous, and resembles the surface of a granulating ulcer. The villous projections are in some instances only the follicles and papillæ of the conjunctiva, enlarged by inflammatory deposit; and acquiring considerable solidity and hardness, they irritate the ocular conjunctiva, especially its upper half, occasioning lachrymation and blinking of the lids. In another and more serious class of cases these are neoplastic formations, and are undoubtedly infectious. The disease is well known as Army, Egyptian, or Contagious Ophthalmia, and results from overcrowding. The early symptoms are very slight; but, by constant attrition, an opaque and vascular state of the cornea is presented, having an almost fleshy aspect—*pannus*. Granular conjunctiva, consequent on purulent ophthalmia, is common among the more destitute Irish population.

Treatment.—Remedial measures have for their object the removal of the granular state of the conjunctiva. The palpebral conjunctiva has been subjected to the rapid action of escharotics, as by the free application of nitrate of silver; or removed, by paring it with a fine knife or scissors. The best applications are the acetate of lead in fine powder, dusted over the everted lid, which acts probably as an astringent; or the undiluted liquor potassæ, dabbed on the everted lid, the latter probably acting by chemically saponifying and dissolving the granular-hypertrophied tissue. Repeated at intervals of a few days, for six or seven weeks, the granulations will probably disappear, and the transparency of the cornea be considerably restored. Counter-irritation, by means of small blisters on the temple, or the tincture of iodine painted over the skin of the lids, seems to aid this result. In army ophthalmia the lids of all the men should be examined twice a week, and where any sago grain-like elevations are seen, the patient should at once be segregated from his comrades, the utmost attention paid to cleanliness, and removal to a pure atmosphere, if possible, effected. In obstinate and otherwise intractable cases, it has been proposed to resort to *inoculation*, for the reproduction of purulent ophthalmia—by applying to the conjunctiva the purulent secretion from the eye of a patient suffering under the acute form of that disease. This desperate remedy has sometimes produced a perforating ulcer of the cornea; but sometimes considerable clearing of an opaque cornea, without any ulceration. It seems reasonable, therefore, to reserve this resource to the last. It has been recently suggested that the patient should be made to wear for a time a glass shield, perforated in the centre, which should be introduced beneath the lids, so that the cornea is not exposed to the friction of the hypertrophied papillæ. The general treatment is always most important; tonics and a nutritious diet have a constitutionally curative influence, without which any local measures are powerless.

(2.) Certain GROWTHS of the conjunctiva require notice.—*Pterygium* is a reddish, fleshy, fibrous growth of the conjunctiva, of a triangular shape; extending, base inwards, from the semilunar fold at the inner canthus to the cornea, or beyond its margin.

It is met with mostly in persons who have lived in hot climates, and exposure to dust may be an exciting cause.

The *treatment* is excision. The lids being held apart with a spring speculum, the growth should be seized with tenaculum forceps, close to the cornea, and dissected carefully off the sclerotic towards the inner canthus; avoiding the caruncle and semilunar fold. Any small portion remaining on the cornea will probably wither and disappear.

Pinguecula signifies small yellowish elevations on the sclerotic, close to the margin of the cornea. They consist chiefly of fibrous tissue. They form after the middle period of life, especially in persons who have been much exposed to the weather, or have lived in hot climates.

These little masses are quite harmless, and had better be left alone.

Tumours, such as occur in other parts of the body, may also spring from the conjunctiva. Warty and polypoid growths occasionally arise from this membrane. Early excision is the only remedy. Fatty tumour sometimes forms *under* the conjunctiva, in the subconjunctival tissue. Mr. Dixon has seen a few such cases, in children; the tumours all occupied the same position—the line of reflection of the conjunctiva from the lower lid to the globe. They extended from near the lower edge of the cornea to the outer canthus, elongated in shape, almost like a haricot bean, and partly concealed by the lower lid. An incision through the conjunctiva and fibrous capsule of the tumour readily allowed the fatty mass to be turned out.

Cysticercus telæ cellulosæ.—This parasite is found, very rarely, in the subconjunctival cellular tissue. It appears as a rounded body, about the size of a pea; situated midway between the inner canthus and cornea in two instances. A slight incision lets this body slip out. Its nature will be shown by examination under the microscope.

Stains from Nitrate of Silver.—A dirty sepia tint of the sclerotic is apt to follow the prolonged application of nitrate of silver, as an eyewash. In one case, Mr. Dixon found that the stain almost disappeared under the long-continued application of hyposulphite of soda in solution—ten grains, gradually increased to a drachm, to the ounce of water. It is necessary to maintain the contact of the solution for some time; and this was accomplished by means of an eyeglass, the patient being ordered to draw down the lower lid and fix it against the cheekbone with the rim of the glass, before reclining his head.

DISEASES OF THE CORNEA.—(1.) KERATITIS, OR CORNEITIS.—Inflammation of the cornea is denoted by crescentic vascularity, passing from the edge of the cornea for some little distance into its substance. This characteristic vascularity involves a third or half of the corneal circumference, and the plexus of vessels is so fine that it appears as a small patch of blood smeared upon the surface of the cornea. An inch focus glass will, however, show the vessels composing the plexus. A zone of pink vessels in the sclerotic surrounds the cornea; but this is present also in iritis and other deep inflammations of the eye. Conjunctival vascularity, indicative of ophthalmia, is absent. Profuse lachrymation and intolerance of light accompany corneitis, as in other affections already described. Haziness and opacity of the cornea soon supervene; eventually, softening with a yellow tint, ulceration of the cornea, and suppuration within its substance; or the matter, bursting through the cornea posteriorly, sinks down to the bottom of the anterior chamber—*hypopyon* results. One eye usually suffers and then the other, perhaps as the first is recovering.

Children are most liable, and the disease rarely occurs after the age of twenty. The constitutional condition is generally weakly, and the subjects anæmic and pale. There may be marks of scrofula.

Treatment.—No lowering measures are tolerated. The remedial measures, local and general, so entirely resemble those of Scrofulous Ophthalmia, that any repetition is unnecessary.

Chronic Interstitial Keratitis—so named by Mr. Hutchinson—has been shown by him to be a manifestation of inherited constitutional syphilis. Presenting itself in children and young persons from five to eighteen years of age, this form of corneitis may be recognized by the following appearances:—It begins at the centre of one cornea, as a diffused haziness like that of ground glass. Whitish dots soon beset this haze, forming in the very substance of the cornea. Coalescing, they increase the central opacity. A fine plexus of vessels now overspreads the cornea, deeply pervading the opaque portion; and especially affecting the upper and central part, rather than the lower half, of the cornea. There is no tendency to ulceration. Subsequently, in about two months or earlier, the other cornea undergoes the same form of opacity and vascularity, in like manner.

Diagnosis.—The vascularity will be observed to differ from the leash of vessels in scrofulous ophthalmia, and from the superficial crescentic plexus of ordinary corneitis. Other marks of hereditary constitutional syphilis accompany this affection of the cornea, and particularly a certain characteristic vertical notching of the upper central incisor teeth.* (See Ch. VII., SYPHILIS, Fig. 79.)

The *treatment* recommended is a combined specific and tonic plan, consisting of mercurials and iodides, supported by tonics and a nutritious diet.

Opacities of the Cornea.—These conditions have been noticed incidentally as consequences of various affections of, or involving, the cornea. Corneal opacities are of two kinds—simple opacity, resulting from inflammatory disintegration and interstitial deposit—*e.g.*, *nebula;* and cicatricial opacity, resulting from ulceration, with loss of substance, and cicatrization—*e.g.*, *albugo*, and *leucoma.* The former state of opacity may be simple haziness, and comparatively transient; the latter is a more dense, white opacity, and probably permanent.

But the prognosis will depend very much on the age of the patient. In infancy and youth, when nutritive changes are most active, cicatrices of even large size diminish both in extent and density, until the cornea becomes almost clear in after-life.

Treatment.—Practically, the distinctions adverted to are most important, simple opacity being curable, cicatricial opacity incurable, by art. Any treatment can only be curative by promoting the molecular changes of absorption and nutrition. To this end, weak stimulant washes to the eye, and a generally tonic and dietetic course of treatment, may contribute. The curative influence of mercurials is doubtful.

Ulcers of the Cornea.—The characters of these conditions have been partly described in connection with Purulent and Scrofulous Ophthalmia, and Corneitis. In all cases there is a loss of substance, so that a little pit is formed, the base of which, as well as the cornea surrounding it, is generally cloudy, but occasionally clear, especially in those cases that have been caused by inanition or imperfect nutrition of the body generally. Rheumatic ulcers are usually elongated in form, situated near the margin of the cornea, and accompanied by considerable pain at night. The sclerotic is much congested. Sæmisch's ulcer is a very slowly progressive form of ulceration, in which a groove forms round the margin of the cornea. The epithelium separates from the central part of the cornea, and, if recovery take place, the form of the cornea is modified and more or less opacity produced, which seriously impairs vision. It chiefly occurs in elderly persons.

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* "Ophthalmic Hospital Reports," vol. i. 1858, and "Trans. Path. Soc." vol. ix.

The prognosis of corneal ulcer is favourable, with the exception of the Sæmisch's ulcer.

The *treatment* may be summed up in a few words. The instillation of atropine solution (gr. ii. or iv. ad ℥j. aq.) to relieve irritability, dilate the pupil, and diminish the risk of penetration; rest, to be secured by closing the lids and applying a pad and bandage; local depletion by means of a few leeches; and the administration of certain remedies, as of quinine, cod-liver oil, and a little grey powder in the ulcers of children, or T. aconiti (♏iii.) and vin. colchici (♏v.—x.) and quinia in the rheumatic form. Sæmisch's ulcer is best treated by passing a Gräfe's knife into the anterior chamber through the margin of the cornea; then turning it half round, and cutting outward through all the layers of the cornea. Nutrition must be promoted by tonics and diet. Of local stimulant applications, by eye-drops or eye-washes, nitrate of silver is the most efficient adjunct to the general treatment. Its use should not be continued too long, lest an insoluble deposit taking place in the ulcer, opacity may result. Lead-lotions, on this account, are wholly inadmissible.

Staphyloma.—Protrusion of the cornea, probably involving the iris, results whenever the cornea, in whole or in part, has been destroyed by injury or disease, and a cicatrix having formed, it there bulges forwards before the pressure of the humours of the globe; presenting an opaque white prominence.

Treatment should be directed to the arrest of such projection. Nitrate of silver applied to its apex may induce just sufficient inflammatory deposit to thicken and strengthen the yielding cornea. A small, conical staphyloma, not involving the iris, may be shaved off, and the edges brought together with a very fine needle and silk; cicatrization will then, perhaps, brace up the cornea and prevent any further protrusion.

(2.) CONICAL CORNEA.—A rare deformity, in which the cornea has become extremely convex, but retains its transparency, and gives a remarkably brilliant appearance to the eye. The conical shape of the cornea is well seen in profile. Dissection has shown that the apex of the cone is very much thinned. The position and movements of the iris remain unchanged, and the other tissues of the eye unaffected. But the patient—usually between twenty and thirty—grows short-sighted, and at last becomes totally blind.

Treatment.—A method of operative procedure suggested by Mr. Bowman sometimes gives good results, but it requires very delicate manipulation. It consists in removing the anterior layers of the apex of the cornea, by means of a small trephine, leaving, however, the posterior lamella. This is now pricked with a needle, to allow the escape of the aqueous humour, and a firm pad and bandage applied. Another mode of relief has been found in compensating optical contrivances. Deeply concave and astigmatic glasses enable the patient to see, in slight cases. A small, pin-hole aperture, in a blackened shield, or metallic plate, held close to the eye, will enable a patient to read at a focus of five or six inches, who could not otherwise discern a letter. Or, a slit, about three-fourths of an inch long, and the thirtieth of an inch wide, allows a considerable range of lateral vision, without moving the head. A combination of concave glasses and this perforated diaphragm, set in a spectacle frame, may prove even more advantageous.

(3.) ARCUS SENILIS.—A circumferential opacity of the cornea, depending, as Mr. Canton has shown, on fatty degeneration. When both eyes are affected, this opacity denotes one of those naturally degenerative changes of nutrition, which the cornea, in common with other textures—especially those of low vitality—undergoes as life advances, say from fifty years of age, onwards. Thus, arcus senilis is often associated with fatty degeneration of the heart. In like manner it may be indicative of premature old age. As affecting one eye, it is generally the result of previous injury or disease of the organ itself. Fortunately, this textural deterioration does not interfere with vision, nor render the texture of the cornea unfit for operation, as the extraction of cataract—the wound then uniting quickly and soundly.

No known *treatment* is of any avail.

DISEASES OF THE SCLEROTIC.—SCLEROTITIS.—Inflammation of the Sclerotic, or white coat of the eye, has been alluded to as occurring *partially* in connection with Catarrhal Conjunctivitis, and with Keratitis, and it also accompanies Iritis. The vascular contiguity or continuity of the textures severally affected with Inflammation, probably explains this concurrence. But Sclerotitis may occur alone, or at least as a primary affection, and more completely than when thus associated.

The whole of the sclerotic is intensely injected, the otherwise white coat assuming a pink tint, shading into violet, owing to the depth of the vessels in the fibrous tissue. Lachrymation and intolerance of light are marked symptoms; with pain deep-seated in and around the eyeball, of an aching and neuralgic character, radiating to the brow, temple, and cheek, and penetrating to the back of the head. Exacerbations occur during the night, and remit towards morning. The constitutional disturbance, also, is intense, the febrile symptoms leading to a copious deposit of lithates in the urine; hence the disease has been named *Rheumatic Ophthalmia.*

Diagnosis from Conjunctivitis.—The redness differs in its colour, being a pale pink, and the injected vessels run in straight lines from the circumference of the eye towards the cornea, there forming a dusky pink zone, of minute vessels, without visible anastomosis—the sclerotic zone; whereas, in conjunctivitis, the colour is crimson, and the vessels are larger, tortuous, and anastomotic, forming an open network, which, moreover, can be moved about under the finger. The intense, deep-seated pain of sclerotitis, compared with the pricking sensation as of a grain of sand in the eye, with conjunctivitis, will confirm the diagnosis.

Treatment.—A free purgation should be followed by opiates, in narcotic doses. Quinine is valuable in proportion to the neuralgic character of the pain; and colchicum with an alkali or iodide of potassium, according to the rheumatic character of the constitutional disturbance. Dover's powder is then a suitable narcotic, its sudorific influence also proving beneficial. In point of diet, sugar and sugar-forming substances should be forbidden.

Local measures seem to be comparatively useless for subduing the inflammation; bleeding, by means of leeches, gives only temporary relief, and blistering aggravates the neuralgia. Steaming the eyes with warm water may afford soothing comfort, with the instillation of atropine, or friction of the forehead every afternoon with extract of belladonna dissolved in warm laudanum, a drachm to the ounce; or dry warmth by means of muslin bags filled with camomile flowers, heated in a saucepan. But perhaps the most soothing application is chloroform, diluted with olive oil, on lint, applied to the temple and forehead. The patient's room should be moderately darkened, and an eye-shade worn.

Chronic sclerotitis does not affect the whole of the sclerotic coat at once, but appears as a limited patch of redness, close to the cornea; this fading away, it reappears elsewhere, always close to the cornea. Eventually, the cornea or iris may become involved, thus inducing opacity, or a very insidious iritis.

Treatment consists in the same remedial measures and observance of diet, as in the acute form of sclerotitis; but this plan of treatment must be pursued more or less for a long time. Any tendency to opacity of the cornea, or iritis, must be checked *in limine;* calomel and opium being administered in small doses, while the circulation is sustained by bark and nutritious food.

THE ANTERIOR CHAMBER.—A living *entozoon*—the *cysticercus telæ cellulosæ*—has not unfrequently been found in this situation. It is a rounded, semi-transparent, vesicular body, having a long, retractile neck, terminating in a head, furnished with suckers and a circlet of hooks. As a foreign body, it excites inflammation of the iris and cornea, ending in total blindness. A crescentic incision along the margin of the cornea lets out the animal with the aqueous humour. Perfect rest and protection from light should then be secured during the process of healing. A bandage, therefore, is worn over both eyes for the first twenty-four hours, and afterwards the wounded eye should still be kept closed as the incision unites and the aqueous humour is re-secreted. Any constitutional management will be suggested by the irritability, weakness, or other state of the patient.

DISEASES OF THE IRIS.—(1.) IRITIS.—Inflammation of the iris presents certain characteristic appearances—chiefly a loss of the peculiar fibrous texture of the iris, a change of colour from dark to reddish or from blue to greenish, diminished size and an irregular shape of the pupil, and early loss of its mobility, with a well-marked circum-corneal zone of redness. Sometimes, the conjunctiva becoming involved, it also is injected; or the cornea appears slightly hazy. Intolerance of light is a symptom common to other ophthalmic affections; and deep-seated, radiating, and paroxysmal pain occurs, as in sclerotitis.

Lymph is effused, producing further changes in the appearance of the iris; its surface acquires a rusty, villous or nodular aspect, adhesions take place forwards to the cornea, or backwards to the capsule of the lens. Sometimes, the pupil becomes occluded with a film of lymph, and the anterior chamber may be occupied by a more abundant effusion. The accompanying impairment of vision is proportionate in its completeness and probable permanency. But, in iritis, the *retina* is often almost as seriously affected as the iris itself; and this concomitant disease has been discovered by the ophthalmoscope.

Causes.—Iritis may have a traumatic origin, and arise as a consequence of various injuries of the eye, or of its over-functional exertion; or the disease may be a local manifestation of various constitutional conditions—secondary syphilis, rheumatism, gout, or scrofula. One or both eyes may be affected; in the former case by injury, in the latter by constitutional disease. But in some such cases, both eyes are attacked at the same time, or in succession, and occasionally the disease is limited to one eye; or, relapses occurring, the eyes may be affected alternately. These manifestations of constitutional disease are all illustrated by Syphilitic Iritis.

Varieties of Iritis.—Inflammation of the iris varies, like other diseases, in its intensity and duration, whereby it is distinguished as the *acute* and *chronic* forms of iritis. But its modifications correspond also, and more particularly, to the constitutionally causative conditions; thence, the syphilitic, rheumatic or gouty, and scrofulous forms of Iritis. Their symptomatic distinctions are far less definite.

(*a.*) *Syphilitic* Iritis.—Lymph-effusion is the most marked feature, taking place rapidly and abundantly; *nodules* of lymph make their appearance, of a yellow, reddish-yellow, or nearly red colour, situated especially about the edge of the pupil, and encroaching upon or even occluding the pupillary area. The cornea often remains perfectly transparent, even when the iritis is most severe. On the other hand, those symptoms which more peculiarly accompany rheumatic iritis are absent—a generally diffused redness of the sclerotic, and great intolerance of light.

Diagnosis.—But the nodular appearance of lymph is so uncertain, as to render its diagnostic value very doubtful. Thus, the lymph may be uniformly distributed around the margin of the pupil, which then assumes a thickened ring-like appearance; the rest of the iris retaining almost or altogether its healthy aspect. Occasionally, nodules of lymph, instead of forming on the edge of the pupil, are situated on the circumference of the iris, adjoining the cornea. These may either soften and form an abscess on the iris, or, enlarging like gummata, burst through the cornea or sclerotic, and lead to atrophy of the globe. Other secondary syphilitic affections of the throat or skin are usually present with, or have preceded, the iritis. This concurrence is far more surely diagnostic.

(*b.*) *Rheumatic* Iritis.—A general diffused redness of the sclerotic, as the most marked appearance, and great intolerance of light, with orbital radiating and neuralgic pain, are the most characteristic symptoms. The cornea is almost always hazy. But the nodular form of lymph-deposit is absent, and effusion takes place so sparingly and insidiously, that the morbid changes in the iris, thus slightly marked, may escape observation, in the first instance. When the inflammation has subsided, and the cornea become clear, irremediable adhesion of the iris may then be discovered.

The disease seems plainly of rheumatic origin, and is frequently associated with other rheumatic affections.

(*c.*) *Scrofulous* Iritis.—The ocular appearances have a general resemblance to those of syphilitic iritis, in the abundant deposit of nodular masses of yellowish lymph, but situated more frequently midway between the pupil and the circumference of the iris, or at this part. Slight hæmorrhage, not uncommonly, takes place into the anterior chamber, from bursting of the distended veins of the iris. The cornea usually remains clear.

Treatment.—Iritis presents certain *general* indications of treatment, irrespective of whatever form it may assume. They are; to arrest inflammatory effusion, and promote absorption of any lymph-deposit; to prevent adhesion of the iris; and to relieve pain. The constitutional treatment will be that of inflammatory fever.

To *arrest inflammatory effusion*, bleeding by leeches must be adopted, or cupping to the temple, followed by blisters, and their action must be maintained by temporary laxative aperients and low diet. Mercury seems to have the power of arresting the effusion of lymph, far more than of inducing its *absorption*. Calomel and opium may be administered, in small doses—say a grain or two with a quarter of a grain respectively, every four or six hours; its influence on the eye being watched, rather than with the view to salivation. Other preparations of mercury, such as hydrarg. c. cretâ, may be given in like manner. Tonics, principally quinine, and a nutritious diet, must soon replace any general lowering measures; thus to re-enforce absorption, by maintaining the circulation.

To *prevent adhesion* of the iris, posteriorly, to the capsule of the lens, or anteriorly, to the cornea; belladonna has the most powerful influence, applied topically, as a means of dilating the pupil and keeping it in that state, removed from the liability of contact. The extract may be smeared around the eye, or a solution of the extract, one scruple in an ounce of distilled water, may be dropped into the eye, occasionally. The sulphate of atropine—a grain to the ounce of water—forms a solution of greater value.

To *relieve pain*, steaming the eye over hot water is a most soothing application; or neuralgic orbital pain, sometimes involving the three divisions of the fifth nerve, a most severe affection, may be relieved by friction with warm laudanum to the forehead and temple.

Syphilitic iritis should be subjected to the same plan of treatment. But, the effusion of lymph being particularly rapid and abundant, mercury should be pushed more freely. Turpentine was recommended by Carmichael, as a substitute for mercury, in cases of great general debility. Its efficacy is very uncertain. Iodide of potassium with bark will probably be found more suitable.

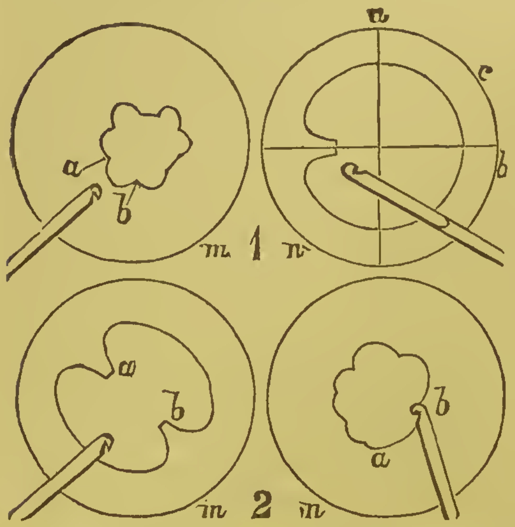
Rheumatic iritis requires the administration of mercury in small doses, to check the insidious effusion of lymph; or turpentine in pill, four grains thrice a day, is most effectual in subduing the iritis, when characterized by visible injection of the iris and sclerotic, without much disposition to lymph-effusion. Some more specific treatment will also be appropriate, as colchicum, aconite, and alkali, or iodide of potassium. The neuralgic pain can be relieved by the means already directed. Blisters will probably aggravate its severity.

Scrofulous iritis is more specially amenable to the general treatment of other manifestations of Scrofula. Quinine, iron, and cod-liver oil, are the chief remedial measures, and must be reinforced by careful regulation of the digestive organs, and a regimen—comprising pure air, daily exercise, warm clothing, and a plain nutritious diet. Local treatment is of little avail.

ADHESIONS OF THE IRIS.—*Synechia posterior*, adhesion of the uvea to the capsule of the lens; *synechia anterior*, adhesion of the iris to the cornea; and *atresia iridis*, closure of the pupil; are three conditions resulting from prolonged iritis.

The *treatment* consists in the application of belladonna or atropine, as a safeguard against any further adhesion, thus to preserve even a partial pupil; and the administration of mercury or of iodide of potassium, in small doses, for some time, after recent adhesions. Established adhesions are curable only by operation. If there be only one, it may sometimes be broken down by making a small opening into the anterior chamber with a broad bent needle or Taylor's knife, through the opposite side of the cornea, and then introducing a Streatfield's hook, as shown in Fig. 618. In this way a single adhesion may be detached with gentle pressure, as in the right-hand upper drawing of figure. If the adhesions are only two in number, and opposite to each other, as in the lower left-hand diagram, the second one may also be broken down by turning the hook. If, however, they are more numerous, one or two only should be attacked at a time, as shown in the left hand upper drawing (*a* and *b*), some time being allowed to elapse before attempting the removal of the other ones. Another method is to make a cut in the cornea on the same side as the adhesion, when a fine pair of forceps may be introduced; the iris near the attached point is then to be seized, and the synechia forcibly broken down. Both operations require considerable manipulative dexterity, as if the capsule of the lens be pricked or torn, the patient will have cataract, and a further operation will be necessary to give the patient vision. Hence neither operation should be undertaken unless the synechia is productive of serious inconvenience to the patient.

FIG. 618.*



Staphyloma sclerotica is apt to follow complete posterior synechia and closure of the pupil with lymph. The aqueous humour secreted in the posterior chamber, being unable to pass through the pupil to the anterior chamber, continues to accumulate behind the iris; gradually bulging the iris, it also distends the anterior portion of the sclerotic; and this yielding forms a bluish-black prominence, streaked with the widely separated whitish sclerotic fibres.

(2.) CYSTS OF THE IRIS are either congenital, or the result of injury by allowing the aqueous humour to find its way between the uvea and fibrous tissue of the iris. A cyst, there situated, might be mistaken for a cysticercus or a dislocated lens; but it is principally distinguished by having a fixed attachment. An increasing cyst destroys the whole eyeball.

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* These drawings show the mode of procedure required to break down posterior synechiæ with Streatfeild's hook.

The *treatment* may be that of removal; by an incision through the cornea, withdrawing the cyst and cutting it off. Or—as Mr. Walton recommends—puncturing the cyst with an iris-knife allows it to collapse. This operation may have to be repeated.

(3.) Myosis and Mydriasis signify, respectively, a persistent contraction or dilatation of the pupil; unconnected with any apparent structural disease of the part, and arising from purely functional causes. *Contraction* sometimes takes place in persons accustomed to examine minute objects; and, the iris refusing to dilate, this state is accompanied with impairment of vision, especially in a feeble light.

Rest of the over-used organ is the obvious indication of treatment.

Dilatation may result from the application of belladonna to the eye, or the long-continued influence of other narcotics. It may be caused also by pressure affecting the brain, as in apoplexy and compression; and it is frequently symptomatic of confirmed amaurosis. It is said to depend, occasionally, on some eccentric source of irritation, as gastric irritation. Lastly, it may be symptomatic of an affection of the nerves supplying the iris, without any loss of sensibility of the retina; and this form is perhaps accompanied by ptosis and external squint, as a further symptom of paralysis of the third or motor-oculi nerve.

A tonic plan of *treatment* will generally be appropriate. Mr. Taylor recommends nux vomica; and derivation by means of a succession of blisters to the temple has proved beneficial, with the application of stimulating vapour, as of ammonia, to the eye. Improvement of vision —the retina retaining its sensibility—may be aided by habitually using appropriate concave or convex glasses.

(4.) Artificial Pupil.—*Operations* for the admission of light through the iris are of three kinds, all of which are comprised under the term formation of an artificial pupil. (1) The formation of a new aperture in the iris, when the portion forming the natural pupil has prolapsed through a breach in the cornea; (2) the reopening or the enlargement of the natural pupil, when obstructed by inflammatory deposit; and (3) the displacement towards a transparent part of the cornea of a pupil which has become concealed behind a dense corneal opacity.

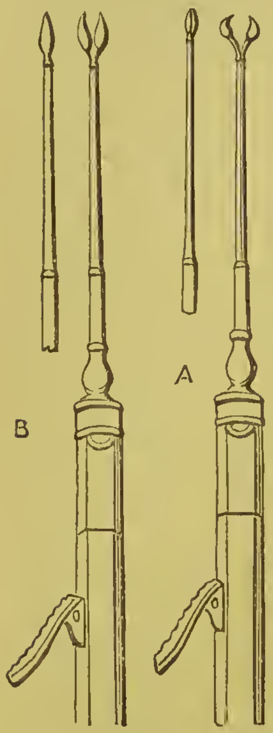
The following *conditions* are laid down by Mr. Dixon as essentially necessary to be observed, before having recourse to any kind of operation for artificial pupil:—*Firstly*, whether the eye perceives light; mere obliteration of a pupil will not deprive the eye of this power, provided the retina be sound. *Secondly*, the presence or absence of the lens must, as far as possible, be ascertained; and, if present, whether it is transparent or opaque. *Thirdly*, the cornea must be carefully examined, as to its degree of transparency. *Fourthly*, the state of the iris. The existence of chronic iritis would indicate a postponement of the operation until inflammation has ceased. A thickened iris, in which all trace of its peculiar fibrous texture has disappeared, is specially unfitted for operation; as it breaks away under the slightest traction, and, if cut, the wound does not gape, so as to form a permanent aperture. *Fifthly*, as a rule, when the other eye is perfect, it is undesirable to operate.

The *situation* of an artificial pupil should be made as near the centre of the iris as circumstances will allow. The size of such pupil should not be unnecessarily large. Injury to the cornea should be as restricted as possible; the cicatrix encroaching on a cornea, which already has a limited area of transparency, will still further diminish the field of vision.

The different modes of making an artificial pupil may be arranged under the heads of division and excision of the iris.

Division is performed by means of a cutting-needle, or with scissors. The needle is introduced close to the edge of the cornea, and carried across the anterior chamber to a little beyond the middle of the iris; the edge is then turned backwards, and the iris divided to the requisite extent. The instrument is rotated into its original position and withdrawn. Scissors may be used for dividing the iris—as proposed by Maunoir—and an ingenious form, termed cannula scissors, which can be introduced through a very small opening in the cornea, are now made by Messrs. Weiss. (Fig. 619.) Neither a linear nor V-shaped incision, however, can be easily accomplished when the iris is flaccid from the escape of all the aqueous humour.

FIG. 619.*



The principle of this mode of forming an artificial pupil consists in utilizing the elasticity of the fibres of the iris; retraction immediately following their division, and thus the formation of an artificial pupil. The probability of success will, therefore, be proportionate to the tension and the healthy retractile power of the iris. But this operative procedure is contra-indicated by a contrary state of the iris, and by the presence of the lens behind, which will almost surely be injured by a cutting instrument. Hence, the operation is restricted in its application to cases wherein, cataract having been extracted, prolapsus iridis has followed to such an extent as entirely to obliterate the pupil, and the iris is put on the stretch by its inclusion and union with the corneal cicatrix.

Excision or Iridectomy.—This operation is especially indicated in cases where, from wounds or ulcers of the cornea, anterior synechiæ or adhesion of the iris to the cornea has taken place; secondly, in cases where, from iritis, posterior synechiæ or adhesion of the iris to the capsule of the lens has occurred; thirdly, in cases where, the iris being perfectly healthy, the pupil is concealed by a dense central opacity of the cornea, the periphery of the cornea retaining its transparency; fourthly, in certain cases of cataract, where the opacity of the lens is central, whilst the margin remains clear; and, lastly, it is frequently practised for the relief or cure of glaucoma and glaucomatous conditions of the eye. It is a delicate operation; requires sharp instruments, a steady hand, some practice; and must, as a rule, be performed with the patient under the influence of chloroform. The steps of the

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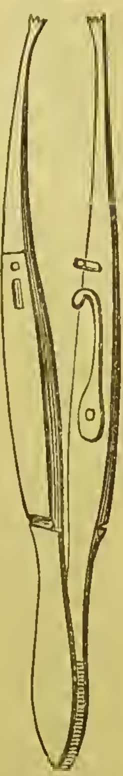
* This figure shows, at A, a pair of cannula forceps in a closed condition, as it should be introduced through a small opening in the cornea, and open, as it should be when no pressure is made on the lever forming part of the handle, and when it is ready to grasp the portion of iris-capsule or foreign body for which it has been introduced into the eye. At B is shown a pair of cannula scissors in the same conditions.

Fig. 620.*



operation are that the patient being in the recumbent position, in a good light, and the lids being separated with a speculum, the conjunctiva is seized with a pair of fixing forceps (Fig. 620) on the side opposite to that on which the knife is to be entered. A knife with a triangular blade, which is either straight, or bent at an angle with the handle, and is called a keratome, is then slowly introduced at the point of junction of the cornea with the sclerotic, or a little behind this point, care being taken that the point of the blade neither scrapes the cornea nor wounds the iris. (Fig. 621.) After the opening has been made of sufficient size—and it is better to make it too large than too small—on the withdrawal of the knife, which should be done slowly, a pair of curved iridectomy forceps are introduced through the wound, with the blades in contact. On opening and again closing them, a portion of iris of the required size can be seized and drawn out of the wound, when it is to be divided with scissors. (Fig. 622.) When iridectomy is performed for posterior synechiæ, the piece of iris seized with the forceps should be withdrawn with the greatest gentleness and care, lest the capsule of the lens be torn through. Hæmorrhage sometimes takes place into the anterior chamber, and obscures the steps of the operation. In old cases of iritis the iris becomes either tough or friable, and only small strips or fibres can be torn away. The after-treatment consists in the application of a pad and bandage, and rest for a few days. In favourable cases, when the operation has been done skilfully, the subsequent pain and irritation are very slight. If, however, in an unhealthy eye, the capsule of the lens have been injured, panophthalmitis may set in, requiring the excision of the globe.

Fig. 621.†

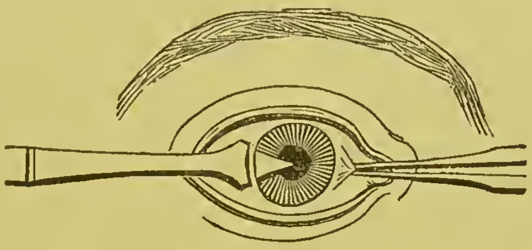
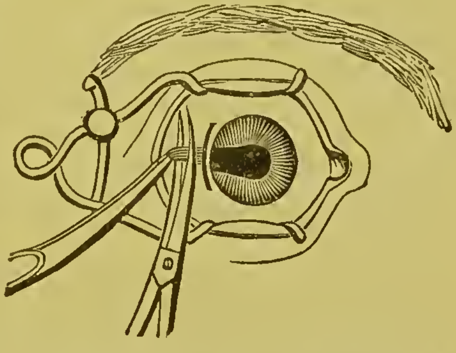


Fig. 622.‡



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* Fixing forceps. Many prefer the instrument to be made without the catch.

† The first stage of the operation of iridectomy. The conjunctiva is seized with the forceps, and the keratome is shown in the act of penetrating the cornea.

‡ Showing the second stage of the operation of iridectomy. The lids are separated by the speculum. A portion of the iris has been seized and withdrawn, but is still held by the forceps, which should have rather a sharper curve, and the piece is about to be cut off by the scissors. The division should, however, be nearer the base or cornea than is represented.

Ligature.—A puncture is made through the cornea for the introduction of a pair of curved forceps, a small portion of the iris near its ciliary attachment is seized, drawn out through the wound, and tied with a very fine silk thread. This transforms the pupil into an elongated slit. If this aperture be insufficient, it may afterwards be enlarged by ligature of a second portion of the iris, so as to draw the pupil into a triangular shape.

This operation—devised by Mr. Critchett, and named *Iriddesis*—limits the size of the pupil, and is applicable to a certain number of cases; as when prolapse of the iris has occurred, involving so much of the pupillary margin in the cicatrix, that the area of the pupil is reduced to a very minute aperture; or when the whole pupil has been displaced towards the extreme edge of the cornea, and there concealed by opacity. It has the great disadvantage of leaving a piece of iris in the wound, and thus running the risk of producing sympathetic ophthalmia.

After-treatment of Artificial Pupil.—In a tolerably healthy state of iris, the various modes of operation, if skilfully performed, are attended with little hæmorrhage into the anterior chamber, or inflammatory consequences. Repose of both eyes, by means of a bandage, is necessary for two or three days, and the operated eye should then be kept closed for a day or two more. At the end of a week, a large eye-shade will be sufficient, and tinted glasses should be worn for some time. Any opiates, and the regulation of diet, will be suggested by the constitutional state of the patient.

DISEASES OF THE LENS AND ITS CAPSULE.—CATARACT is an opacity of the crystalline lens or of its capsule, or of both; partial or complete. Agreeably to this definition, cataracts have been arranged under two primary forms: (1) Capsular cataract; (2) Lenticular cataract. We also get (3) a combination of both, which is the most common form, and is named Capsulo-lenticular cataract. *Cortical* and *Nuclear* cataracts are terms proposed by Mr. Dixon, as synonymous with the two primary forms. *Lenticular* cataract, again, is distinguished according to its density, into the *hard* and *soft* varieties. These terms represent only certain stages in the progress of cataract; in no form of the disease does the lens undergo progressive hardening; but the lens, for a long time retaining its naturally firm consistency while opacity is advancing, undergoes disintegration and softening, thus acquiring a uniformly whitish, milky opacity; eventually, perhaps, becoming transformed into a *fluid* condition.

Symptoms, and *Signs* or Appearances of Opacity.—Subjective symptoms, or those which the subject of the disease may himself experience, are not to be relied on as positive evidence; nor need such symptoms be accepted, since they can be *tested*, in regard to any functional defects of the organ. Dimness of sight, more or less marked, uniformly involving the field of vision, coming on gradually, without inflammation, and unattended with any impairment of motor power in the iris, is a suspicious symptom; but supposed defects of visual power should be tested and proved, by the independent observation of the Surgeon.

An examination also of the suspected eye, or of both eyes, must be made; first, in its natural state, and afterwards, when the pupil is dilated by a few drops of the neutral sulphate of atropine,—two grains to the ounce of distilled water. A convex glass, of an inch focus power, should be used as a condenser, to concentrate light upon the surface of the lens; the patient standing in front of a window which admits a good light,—not direct sunlight. The best means of diagnosis, however, is the ophthalmoscope, with the aid of which the faintest striæ and opacities can be readily recognized.

Capsular cataract shows—behind the pupil—an opaque body, of a grey dead-white colour; *Lenticular* cataract, a bluish-white or amber-coloured opacity. Various shapes and shades of opacity are recognized, of subordinate importance, but some of which may be noticed in connection with cataract in adults and infants, respectively.

Cataract in adults.—Usually occurring in advanced life—after the age of fifty or sixty—the rise and progress of cataract in elderly perrons are as follows:—The circumference of the lens is first affected, commonly the lower edge, in the form of opaque striæ, which gradually advance along the posterior and anterior faces of the lens towards its axis. These striæ coalesce into patches, spreading chiefly over the posterior surface of the lens. In this state, the cataract may remain stationary for a year or several years. Then, the whole body of the lens, and especially the nucleus, becomes slightly hazy; through which, however, the posterior radiated opacity can be discerned,—the eye being illuminated with concentrated light. The anterior surface becomes involved, the opaque striæ advancing from the margin, until the points come within the area of the pupil. As the central opacity acquires greater density, vision is lost, excepting to strong light and bright colours. The fibrous structure of the lens gradually disappears with increasing opacity; disintegration proceeding, a deposit of earthy and fatty matter takes place, and crystals of cholesterine just within the capsule may sometimes be recognized by their sparkling appearance. These further changes are limited to the surface of the lens, and present a *whitish* opacity. Sometimes they do not occur, and the cataract has a dull *brownish* appearance like horn, very difficult of detection. *Black* cataract is a rare form of lenticular opacity; it appears to be due to the absorption of hæmatosine.

Fluid cataract results from softening, which begins in the superficial portion of an opaque lens, and involves the whole lens, until, in the course of years, it becomes converted into a thin pulp. The nucleus resisting this change may be surrounded with a turbid pulp of disintegrated tissue; a lens in this state constituting the "Morgagnian cataract."

Congenital Cataract shows various forms of opacity; the most common is the *laminated*, where there is an opaque nucleus, while the peripheral portion remains more transparent. Other forms are, a small, white, central dot on the anterior face of the lens—*central* cataract, a diffused opacity occupying nearly the whole area of the pupil when contracted. This opacity projects forward in the shape of an obtuse white cone, which appears to adhere by its base to the anterior surface of the capsule—*pyramidal* cataract; and, lastly, a very faintly striated opacity of the nucleus, a rare form of congenital cataract.

Traumatic Cataract.—In consequence of a blow on the eyeball, or a penetrating wound of the lens, the lens may become opaque; the latter injury inevitably producing cataract. Disintegration and absorption of the lens ensue; the opaque capsule remains. Iritis having been caused by the injury, the pupillary margin will probably be adherent to the capsule. Thus, then, an opaque white disk occupies the area of the adherent pupil; but this disk is situated much further back than the position of a full-sized lens. Sometimes, other appearances are presented.

Dislocation of the Lens into the Anterior Chamber.—This injury may be conveniently noticed here. It is produced by external violence, such as a blow upon the eye, or a violent fall. Disease may have predisposed to it by weakening the suspensory ligament of the lens. This body may itself have become opaque, when its appearance in the anterior chamber will at once be recognized. In a transparent state, the dislocated lens is remarkable; its margin exhibits the appearance of a ring of golden light. Pain and inflammation soon supervene. Prompt removal of the lens, through a suitable opening in the cornea, is the only treatment for saving the eye.

TREATMENT OF CATARACT.—No mode of cure, otherwise than by operation, is at present known; nor has any approach to a non-operative cure been discovered.

Operations.—(1.) Extraction of the lens, by which the opaque lens is removed entire from the eye, through a suitable wound in the cornea. (2.) Displacement of the lens; either by depression downwards, or reclination backwards, downwards, and a little outwards. "Couching," as this operation has been termed, displaces the lens from its natural position into an attitude so that, although remaining within the eye, it allows the rays of light to pass unimpeded through the pupil to the retina. (3.) By Solution or Absorption. This operation consists, not in the "division" and breaking-up of the whole lens (a proceeding which still finds favour on the Continent, and was formerly practised in this country), but in the laceration of the capsule so as to expose the tissue of the lens to the macerating influence of the aqueous humour, whereby it undergoes complete absorption—a principle of operation established by Saunders, Tyrrell, and other English Surgeons.

Extraction.—(1.) By *Flap-Operation.*—The *instruments* required are these:—A knife having a triangular blade; the back straight and blunt, the point sharp, the edge slanting obliquely and the blade increasing in thickness and breadth towards the handle—Beer's knife. A blade thus shaped occupies the incision in transfixing the cornea, and a semilunar-shaped incision can be made by simply an onward movement with the knife. A curette, or an instrument with a curved needle at one end and a small spoon at the other. The guarded curette devised by Mr. Walton, is a safer form of this instrument. A sharp hook may also be requisite.

The directions to be remembered in performing the operation are as follow:—To make a crescentic incision in the cornea, through its upper half, and of sufficient size to afford an easy exit to the lens; to make the incision at such a distance from the sclerotic as to insure both edges of the wound being wholly of corneal tissue; to lacerate the anterior capsule freely, so as to allow of the lens readily slipping through the rent when pressure is made on the globe; lastly, to apply this pressure gently, in such manner that the lens shall turn slowly on its transverse axis, and thus present its upper margin first at the pupil and then at the corneal wound.

These directions are best fulfilled by the following mode of performing the operation of Extraction:—The patient lying on his back with the head supported, and in a good light, the Surgeon stands behind and uses his right hand for the right, and his left for the left eye. An assistant draws down the lower lid, and steadies it on the malar bone, without any pressure on the eyeball. The operator, with the point of his forefinger, raises the upper lid, locks it under the margin of the orbit, and by resting the point of that finger gently on the upper surface of the globe, and his middle finger against its inner surface, he steadies the eyeball. Holding the knife lightly between the thumb and first two fingers of the other hand, and resting the hand against the side of the face, he punctures the cornea at the centre of its outer margin, a *short distance in front* of its junction with the sclerotic, pushes the blade onward through the cornea, parallel with the iris, and transfixes the other side of the cornea, exactly opposite the external puncture. Owing to the triangular shape of the blade, this incision forms an even semicircular flap of the upper *half* of the cornea. In making this cut, the blade must constantly fill up the wound, by a steady, onward movement. If the knife be in the least withdrawn or rotated, a jet of aqueous humour takes place at that part of the wound which is no longer occupied by the blade, and the iris immediately prolapses over its edge—a perilous juncture. Having completed the incision, the eyelids should be dropped, and all pressure instantly ceased. After a few seconds, the Surgeon again raises the upper lid, and introducing the curette under the corneal flap and through the pupil, he *freely* lacerates the capsule of the lens, so that the rents shall extend quite across the area of the pupil. Lastly, very *gentle pressure* is made on the under and upper part of the globe, alternately, whereby the lens turns slowly on its axis, and presents its upper edge at the pupil; coming forward to the cornea, the edge is guided upwards, and protruding, the lens escapes through the wound. During this transition of the lens forward, pressure on the globe should be gradually relaxed, lest the escape of the lens be followed by a gush of vitreous humour. The operation is concluded; but, after a short pause, the eye should be inspected to see that the iris is not prolapsed and that the cornea is adjusted.

Complications.—Prolapsus of the *iris* during the corneal incision may be rectified by slight pressure over it in completing the incision; or, division of the fold of iris being unavoidable, the resulting aperture should be laid into one with the pupil by at once dividing the intervening strip of iris. An *insufficient* corneal incision must be enlarged by means of a short, narrow, blunt-pointed knife, or by scissors. A portion of the *lens* accidentally left behind, *in situ*, will be absorbed; or, from the anterior chamber, it can be easily removed by the scoop. Escape of the *vitreous humour*, resulting from an insufficient corneal wound and undue pressure on the eyeball, rupturing the hyaloid membrane, is attended with sinking down of the lens into the space left by the lost humour. Pressure must at once cease, and the lens be extracted by means of the scoop or hook entered *behind* the body, which should be retained in position against the cornea, lest it sink deeper into the vitreous humour. *Hæmorrhage* into the vitreous humour is the most dangerous complication of all. Severe pain in the eye, and oozing of blood from between the lids, soon proclaim the nature of this accident, but not until the whole cavity of the eyeball has become filled with blood. The sight is utterly lost.

Conditions contra-indicating, or *unfavourable* for, Extraction.—(1.)

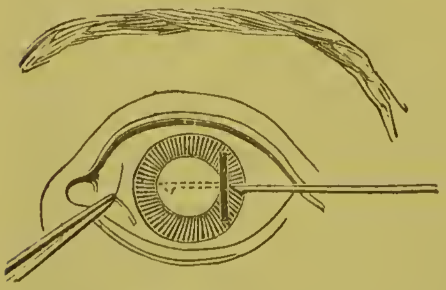
Extensive heart-disease is most unfavourable, by enfeebling the supply of blood necessary for reparative union of the cornea. (2.) Violent cough, of paroxysmal character, perils closure of the wound, and also prolapse of the iris. (3.) Fat and flabby persons have less reparative power than thin and wiry, albeit old, people. (4.) Old age does not contra-indicate the operation; in one case Mr. Dixon operated on a gentleman of eighty-six, and four years afterwards he still enjoyed excellent health and good sight. Commonly, however, after seventy, the reparative power of the cornea is impaired. (5.) If one eye only is affected with cataract, the other being free or nearly so, the operation should generally be deferred until vision is materially impaired in the other. (6.) If cataract be equally advanced in both eyes, and both appear equally suited for operation, it will generally be preferable to operate on only one eye at a time. Much may be learnt of value with regard to the second, by watching the first operation. (7.) Extremes of hot and cold weather are unfavourable for the operation, and more especially sultry weather.

After-treatment.—The patient having been put to bed, with his shoulders somewhat raised, seclusion and darkening of the room are the circumstances most conducive to recovery. The wound of the cornea, protected by the lids, requires only to be covered with a piece of soft, dry, linen rag, lightly retained by a turn of bandage. The bowels should be kept easily opened, without straining or relaxation; and everything likely to excite coughing, sneezing, or vomiting should be avoided. A moderate diet may be allowed. In from four to seven days, according to the probable reparative power, the eyelid may be raised, and the corneal wound and iris examined. All going on well, the patient may be allowed to move about a little; and at the end of another week, if union be sound, the eye may be opened in a weak light, and gradually brought into use. Any exposure to a strong light, or cold, or over-use of the eye, must be avoided. A shade should be worn, and a convex glass used, but it will be difficult to make the two eyes act in harmony.

Inflammation after the operation has been always a great bugbear. But, in a healthy subject, and after a skilful operation, the cornea unites without inflammation, almost as readily as other soft textures. The state of the eyelids and secretion will indicate the supervention of inflammation, and the necessity for any antiphlogistic measures.

Very rarely, a fistulous wound results, and proves most troublesome. The aqueous humour constantly draining away, the anterior chamber becomes obliterated and the iris lies in contact with the cornea. When this state has existed for several years, all useful vision will be lost.

FIG. 623.



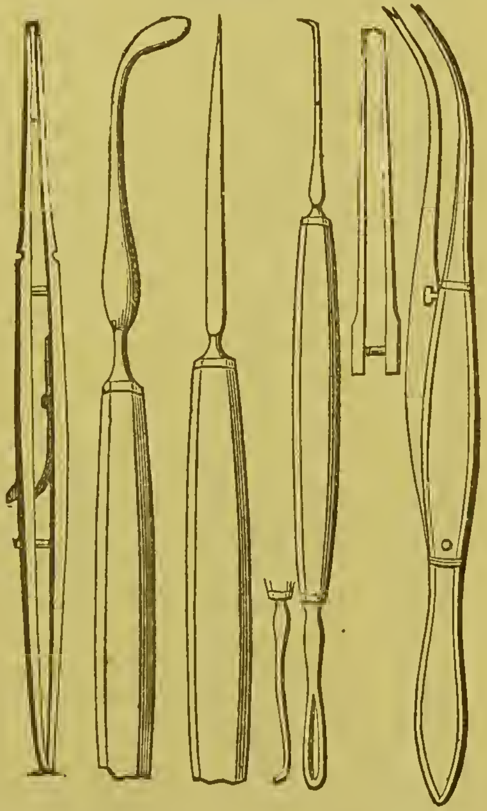
(2.) *Linear Extraction.*—Originally invented by Gibson (1811), Graefe's operation (1855) is performed as follows:—The pupil being dilated with atropine, a straight vertical incision with a narrow knife, like a sharp-pointed tenotome, is made about a line on the side of the cornea, passing through it to the extent of two and a half or three lines in length. (Fig. 623.)

A small fleam-shaped cystitome is introduced, and the capsule and substance of the softened lens are broken up. Lastly, a scoop is passed into the pulpy mass, and pressed against the margin of the wound so as to make it gape, whereby the lens-matter escapes along the groove of the instrument.

Soft cataract is the only condition of cataract suitable for the linear operation. The advantages of this method are principally two: the linear incision is less gaping, and it heals more readily than the curvilinear flap-wound, the edges of which do not remain in such even coaptation; so that there is less risk of prolapsus of the iris.

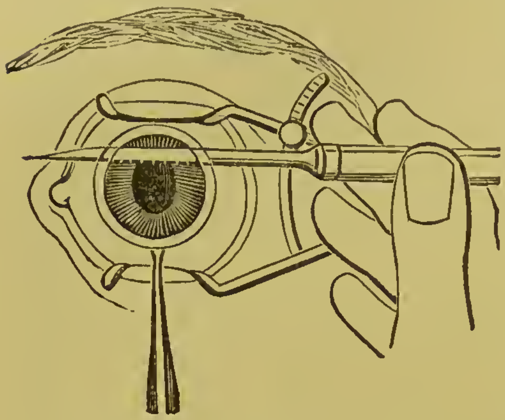
Scoop-Extraction—a modification of linear extraction—was also devised by Graefe (1859). It is applicable in that condition of soft cataract where, with partial softening, the operator finds a firm and large-sized nucleus, the extraction of which would otherwise be attended with injurious pressure on the iris, and might leave fragments of lens-matter behind the iris as a source of dangerous irritation. Hence the use of a scoop for traction of the nucleus, through a wound less gaping, and with more perfect coaptation, than a flap-wound, in both ways still preventing the liability to prolapsus iridis, which is of common occurrence after that operation. Scoop-extraction is performed in the following manner:—If the patient be restless, chloroform may be administered, considering the little liability to any escape of vitreous humour—the corneal wound being small, and extraction accomplished without any pressure on the eyeball. A spring speculum is introduced to keep the lids well apart and expose the globe, which is then fixed in position by nipping up with fine forceps a fold of ocular conjunctiva below the cornea. A lance-shaped knife, or Sichel's extraction-knife, is then entered at the upper edge of the cornea, close to its junction with the sclerotic, and the blade carried upwards so as to make an incision of sufficient length for a considerable iridectomy. Passing a fine forceps into the wound, a portion of the iris is seized, drawn out, and excised. The cystitome is then introduced, and the anterior capsule lacerated. Lastly, the scoop, or Critchett's spoon or "vectis," is gently insinuated behind the upper margin of the nucleus, and curved round until the end of the instrument is just beyond the lower margin—observing, in thus passing the scoop, not to incline the point so far backwards as to penetrate the vitreous humour. The scoop, fairly holding the nucleus, is gently drawn out of the wound, bringing with it that body. Pulpy lens-

FIG. 624.



matter remaining, may now be extracted in like manner, by re-introducing the instrument once or twice; but not with too much concern for the removal of every particle, provided no solid nodules remain. The corneal wound must be left free of any lens-matter, clot, or portion of iris.

FIG. 625.*



Modifications of Graefe's scoop-operation, with iridectomy, have been practised. A crescentic incision of the cornea may be made, and the lens removed, as in flap-extraction. Then, the iris is seized with forceps, drawn out of the wound, and excised. Or, iridectomy may be first performed, and the corneal wound allowed to heal; when, by a second operation, scoop-extraction is performed, *minus* iridectomy.

FIG. 626.†

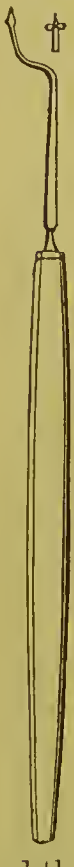
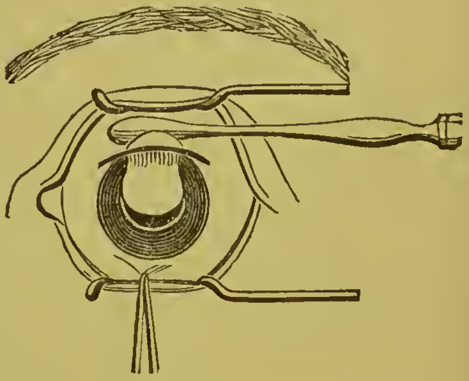


FIG. 627.‡



Modified Linear Extraction.—This, the latest form of Extraction, according to Graefe's method, consists in making a considerable corneal incision, and extraction of the lens entire by pressure. The lids being well separated by a wire speculum, and the eyeball fixed with forceps, "the knife, which is long and very narrow, is made to pierce the sclerotic at about the distance of a third of a line from its junction with the upper and outer part of the cornea, so that the instrument, as it is thrust in, enters the anterior chamber quite at its re-entering angle. (Fig. 625.) Having got the point clear into the chamber, it is thrust on for a short distance downwards and inwards; the knife is then lowered into a horizontal position, and the point brought out in the sclerotic at a spot opposite to that of its entrance; the edge of the blade, which had been kept upwards, is, lastly, to be turned a little forwards, and the corneal section completed. The wound now lies under the still undivided conjunctiva; this is then cut through with the knife, so as to leave a little flap of the membrane loosely covering the wound." The upper part of the iris is removed with forceps and scissors, to a sufficient extent, and the anterior capsule freely lacerated with the cystitome. (Fig. 626.) "The curette is then laid upon the lower part of the cornea, and pressed in a direction upwards and backwards, whereby the upper edge of the lens is presented at the section (Fig. 627), and as the lens slowly advances, its egress is aided by the curette being steadily carried upwards with gentle pressure, over the surface of the cornea;" any detached portions of the soft periphery of the cataract are also guided upwards by repeating this gliding pressure with the curette. Abrasion of the cornea may be prevented by using, as Graefe advises, a curette of vulcanite instead of silver.

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* First step of Graefe's modified linear operation. † Cystitome.
‡ Last step of Graefe's modified linear operation.

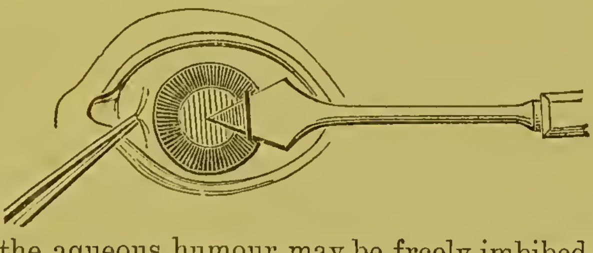
Displacement or *Couching.*—This operation for cataract is performed by introducing a curved needle through the sclerotic, just behind the margin of the cornea, and in the transverse axis of the globe; penetrating the vitreous humour, the posterior aspect of the capsule of the lens is lacerated with the point of the needle, which is then carried upwards and forwards behind the iris to the front of the cataract, and the lens gently and steadily *depressed* downwards into the vitreous humour, until it is passed out of sight. There having been held for a few seconds to fix it in its bed, the needle is withdrawn. *Reclination* —a modification of depression—is performed in like manner; the lens being reverted backwards, downwards, and a little outwards. For either mode of this operation, the pupil should be dilated by a few drops of the solution of atropine, applied about an hour previously.

Displacement of the lens has all the attractive advantages of simplicity, rapidity, and immediate restoration to sight. But the chance of some structure essential to vision being injured by a wound in the dark during the operation, or of inflammation supervening in consequence of the lens, as a foreign body, sinking further down on to the retina, or falling forwards against the ciliary processes and iris, make a sum total of accidents adverse to this procedure.

The conditions favourable for displacement are such hard cataracts as may not be suitable for extraction.

Operation for Solution and Absorption.—In this operation, which is well adapted for soft cataracts, and which may be employed in most cataracts occurring under the age of thirty, the steps of the operation are, in the first instance, to dilate the pupil thoroughly by the instillation of a solution of atropine, containing four grains to the ounce. The patient being placed under the influence of chloroform, the lids separated with the speculum, and the conjunctiva seized with a pair of fixing forceps to steady the globe, a sharp needle, so made that it will not penetrate the eye to a greater depth than one-third of an inch, is slowly pressed through the cornea into the lens. If it be only rotated, the operation is termed *drilling*, but more commonly the capsule is somewhat extensively torn, in order that the aqueous humour may be freely imbibed by the substance of the lens. Atropine should again be instilled, a pad and bandage applied, and rest enjoined. In some instances little or no

FIG. 628.*



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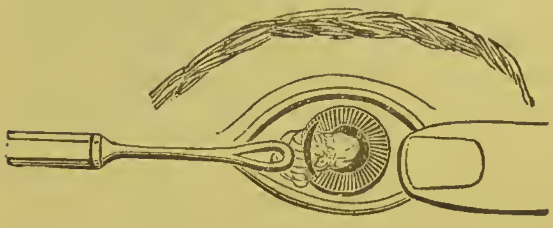
* First step of operation for removal of softened lens after operation for solution. The speculum is not shown, but the keratome is seen entering the globe at a short distance from the periphery of the cornea, the point entering the softened cataract.

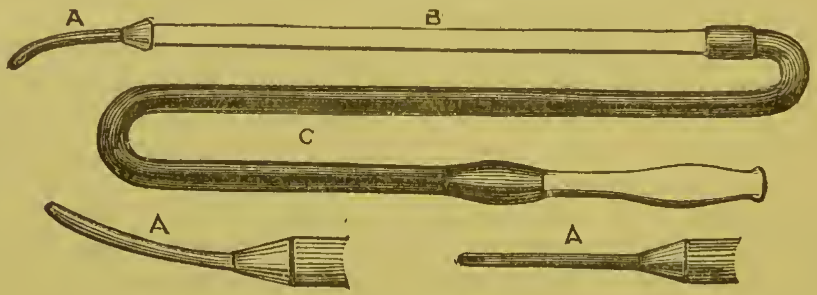
reaction takes place, and the operation may be repeated in the course of ten days or a fortnight. Generally, however, the lens swells and projects into the anterior chamber, and more or less pain is experienced in the eye, which becomes increased in tension and presents other symptoms of iritis and iridocyclitis. If this occur, an attempt should be made on the fourth or fifth day, or later, to remove the greater part of the swollen and softened lens. This may be accomplished by passing a bent needle or a keratome through the cornea (Fig. 628), but not too close to the margin, to avoid the chances of prolapse of the iris into the lens; one or other of the various forms of scoop may then be made to enter through the wound, and, with a slight lever-like movement, a large portion, if not all, of the cataract may be extracted. (Fig. 629.) In these proceedings as little injury as possible should be inflicted on the eye, and the iris should in no case be bruised or abraded.

Fig. 629.*



Instead of introducing a scoop, the second step of the operation, originally suggested by Laugier (1847) as the method *per aspiration*, consists in removing the softened lens by *suction*. The apparatus required for this purpose is shown in the accompanying diagram. (Fig. 630.) It consists of a perforated curette or cannula of silver (different views of which are shown at AA), the extremity being smoothly rounded and the opening being at a short distance from the extremity. To this is attached a glass tube, B, to enable the operator to see what quantity of lens-substance he is extracting; a short piece of india-rubber, C, succeeds, ending in a glass mouthpiece. In using it, an opening is made in the cornea with a bent needle, small, yet sufficiently large to permit the entrance of the nozzle, A, without force. The operator then sucks at the mouthpiece gently, and the lens substance will be seen to rise in the tube B. The principal objections to the instrument are that it is extremely difficult to keep the nozzle and tube near the extremity clean, and that the opening is apt to become choked with a hard fragment of lens; whilst, if the suction power be increased, it is sometimes taken up

Fig. 630.†



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* Second step in the operation for solution. The wound made in the cornea by the keratome is shown, with the scoop about to be introduced for the purpose of removing the softened lens.

† Apparatus required for removal of cataract by suction.

suddenly, and damage is done to the iris or to some other internal structure of the eye. In the method of suction proposed by Mr. Teale, in 1863, instead of the above-described apparatus, a syringe, with tightly fitting piston, is employed; but the instrument is open to similar objections. Whichever of these methods of treatment is adopted, a portion of the posterior capsule often remains, for the removal of which two needles may be used together, in order to more effectually tear the extensible texture of the capsule; but the one should be passed in until its point reaches the middle of the pupil, before the second one is introduced through the cornea.

Both eyes may be operated on simultaneously, in infants; but one eye—that most affected—should be operated on first, in adults.

A *fluid* cataract having been subjected to solution by the needle, distressing sickness and perhaps intense neuralgia occasionally sets in immediately. The anterior chamber is full of creamy fluid, concealing the iris. On evacuating this fluid, by means of a broad cutting-needle introduced at the point of puncture, the sickness may be averted. Nausea is best relieved by swallowing fragments of ice, and the neuralgia by chloroform liniment applied to the forehead and temple.

The *after*-treatment is simple; both eyes should be kept closed by means of a light bandage for twenty-four hours, when the little puncture-wounds in the cornea will have closed. A single operation may suffice to procure absorption, in the course of a few weeks, but this is a rare result; usually, it must be repeated again, and a third time, at an interval of two or three months.

An *Opaque Capsule* or *Capsular Cataract*, remaining after the operation for solution, must itself be removed. This can be done by either of three operations. (1.) One or two needles or a Taylor's knife may be introduced as for depression, and the opaque capsule torn or cut through; as it shrinks away, the pupil becomes clear. (2.) The upper part of the capsule, for four-fifths of its circumference, may be detached by the needle from the suspensory ligament, and then be pushed down below the pupil. (3.) These operations having failed, an opening may be made in the cornea, through which the opaque capsule is extracted by means of a small hook or forceps. The latter instrument should be so constructed that when its points are separated, the iris shall not fall between them. Such is the cannula-forceps.

Operations on Infants.—Congenital cataracts should be operated on at an early period—within four months after birth; otherwise, the eye born blind, constantly oscillating from side to side, may never acquire directed vision. The child reclining under the influence of chloroform, and the head being steadied by an assistant, the operation for *solution* should be performed. The lens is so soft, that this procedure may be completed at once, and on both eyes. A bandage is then applied. Inflammation rarely supervenes, and absorption takes place rapidly.

Diseases of the Choroid and Retina.—(1.) *Dimness* of sight may be symptomatic of *various* deep-seated morbid alterations in the eyeball, unconnected with any changes in the anterior tissues of the globe, and as discovered by external examination with the unaided vision. Thus, the ophthalmoscope may show masses of pigmentary deposit overspreading the choroidal surface, or an inflammatory state of the eyeball.

(2.) *Defective* sight, as various forms of Daltonism, etc., is apparently unconnected with any morbid state of the choroid or retina, as examined by the ophthalmoscope; although these functional defects are commonly attributed to structural changes in one or other of these tissues.

(*a.*) *Impaired* vision—*Amblyopia* and *Asthenopia*—or weak sight is a defective sight for near objects. It occurs mostly in those persons who are accustomed to use their eyes much in looking at minute objects. Thus, jewellers, watchmakers, copying clerks, tailors, and needlewomen are the common subjects of this affection. Yet it also occurs in those who follow no such occupations, but whose age is that of the turning period of life; say, approaching fifty. At first, small objects or small type are seen clearly, but in a few minutes they grow indistinct. A moment's closure of the eyes restores the power of vision. The work or type again becomes misty, and the effort to see is discontinued. Larger type will enable a reader to continue reading for a while, but ultimately this can be seen with difficulty, especially in artificial light. This condition usually results from the lenses being too flat, or from the eyes being hypermetropic or flattened in the antero-posterior diameter, so that the ciliary muscle requires to be put in action and the lens rendered more convex, in order to bring even parallel rays of light, and *à fortiori* those that are divergent, to a focus on the retina. This muscular exertion soon produces fatigue, which gives rise to the symptoms already mentioned. The treatment consists in the selection of appropriate glasses. In young persons, up to the age of thirty or even forty, the contractile power of the ciliary muscle should be paralyzed by the instillation of solution of atropine. The patient is then placed in a condition in which he is unable to accommodate his vision for near objects, or, in other words, to make his lens more convex. The strongest convex glass, which will enable him to see distant objects, is that which he requires. In some instances it will be found to be expedient to begin with glasses of somewhat feebler power than those giving perfect distant vision, and gradually to rise to the full strength required. In those over forty years of age the instillation of atropine may be omitted, and the glasses ordered which enable distant objects to be seen with distinctness. In the presbyopia of old age, which results from the natural flattening of the lens to which all eyes are subject, and which is in progress from childhood, such glasses should be given as enable the wearer to read ordinary print with comfort at a distance of eight or ten inches. A convex glass of forty inches' focus will usually be found agreeable to begin with, and these may, at moderate intervals of time (one or two years), be increased to ten inches, beyond which it is rarely requisite to go if the eye has been originally healthy.

The *treatment* certainly should have reference to the condition as an optical disarrangement, and not to any supposed congestion of the choroid, or disordered digestion.

(*b.*) *Muscæ Volitantes.*—Little black objects are sometimes seen to fall or float over the field of vision, when the eye is fixed; a sudden turn of the eye will disperse them for a moment, again to reappear. Steady concentration of the vision on any external object obliterates these black specks, but any slight alteration of the focus of adjustment, brings one perhaps into view, and immediately the whole field of vision becomes crowded with them. They may be seen moving freely when the lids are closed, if the eyes be turned towards a strong light. These small, black, moving objects are not due to congested vessels of the choroid, but are probably particles of pigment in the vitreous humour. They move freely in a fluid, through a limited space, and at various distances from the retina. The surface of the cornea is not the sphere of action, as proved by their position remaining unaffected in blinking of the eyelids.

Muscæ occur commonly in short-sighted persons, usually commencing to appear between the ages of twenty and thirty; and having attracted the patient's attention, they seem rapidly to increase in number, owing partly to the habit acquired of bringing fresh bodies into focus. Their presence is quite compatible with excellent and life-long sight; but they are *incurable.*

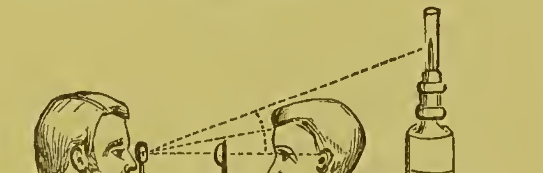
THE OPHTHALMOSCOPE.—It is scarcely more than thirty years ago since Cumming first demonstrated the possibility of inspecting the fundus of the human eye, by means of a certain arrangement of light. An instrument for this purpose, the first ophthalmoscope, was invented by Helmholtz and described in 1851. Ruete followed in 1852, with an ophthalmoscope constructed on a different principle; Coccius modified this instrument, and it was still further modified by Anagnostakis, who reduced its construction to extreme simplicity, and perfected its utility.

This ophthalmoscope consists merely of a circular mirror, about an inch and three-quarters in diameter, slightly concave, and perforated in the centre with a round aperture, the tenth of an inch wide. The mirror is set in a metal frame, fixed in a handle.

The eye of the patient often requires to be prepared for inspection by dilating the pupil with atropine, unless it be already dilated from disease.

The application of the ophthalmoscope, in regard to the various details necessary for a complete examination of the eye, is thus described by Mr. Dixon:—"The observer and the patient sit face to face, in a room from which daylight has been excluded, the only source of illumination being a lamp, or, still better, a jet of gas issuing from a jointed tube, so that the flame can be placed higher or lower, according to the height of the patient's head. The flame should be on a level with his eye, and just far enough behind him to prevent any of the direct rays falling on his cornea. The chimney surrounding the flame must be of transparent glass, and, if faintly tinged with blue, it will modify the red rays of the flame, and impart a whiteness to it, nearly resembling that of ordinary daylight. The

FIG. 631.*



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[*] The mode of examining the eye with the ophthalmoscope. The image thus obtained is inverted.

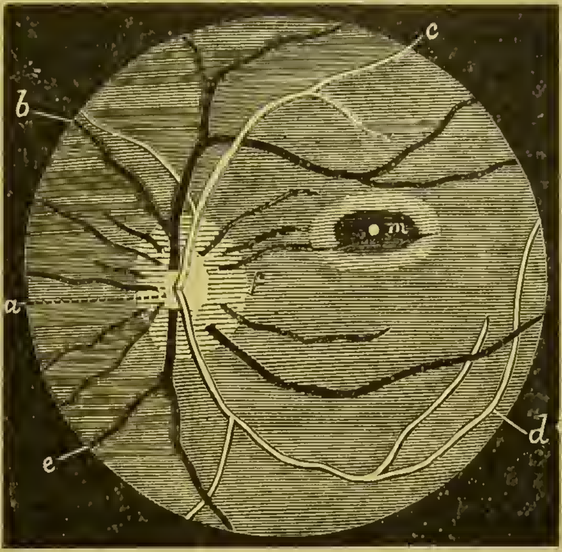
observer places the back of the mirror close to his own eye, so that he looks through the central aperture, and holds the instrument at such an angle that the reflected light from it falls upon the patient's pupil. This is always very difficult for a beginner to accomplish; but a little practice soon makes it easy. The observer will know that he holds the instrument in the right position, and at a proper distance from the eye, by seeing the retina assume a brilliant reddish appearance. Still holding the ophthalmoscope in the same position, he takes in the other hand a convex glass, of two inches or two inches and a half focus, and places it at such a distance in front of the cornea as to allow of the retina coming within that focus. (Fig. 631.) If the fundus of the eye be properly illuminated, and the convex glass correctly placed, some of the retinal vessels will now be distinctly seen.

The principal points to which special attention should be directed, when an ophthalmoscopic examination is made of the interior of the eye, are the appearances presented by the optic disk or papilla, which may be regarded as a transverse section of the optic nerve; by the vessels of the retina, by the macula or yellow spot, and by the general surface of the retina and choroid, it being remembered that the retina is naturally quite transparent. The transparency of the media and the position of any fixed or floating particles in the several media of the eye—aqueous, lens, and vitreous—may in general be readily ascertained by the employment of the ophthalmoscope; and in practised hands, though this requires much experience, the instrument may be made subservient to the determination of errors of refraction.

To bring the optic nerve into view, the *patient* must direct the eye a little towards the nose, and by turning the eye in various directions every portion of the retina is successively brought under the view of the observer. (Fig. 631.) The necessity for varying the position of the eye constitutes a great objection to the more complicated ophthalmoscopes, which are fixed to a table or other support; and some eyes are so unsteady, and so little under the patient's control, that the observer is obliged to follow their movements by slight changes in the position of the ophthalmoscope, which can only be effected when the instrument is held in the hand. The ordinary ophthalmoscope, when used with the lens, presents an *inverted* image of the interior of the eye; the parts being magnified, according to the lens used, from four to eight or nine times their natural size. An *erect* image of the fundus of an emmetropic eye may, however, be obtained by an emmetropic observer by discarding the lens and looking through the aperture of the mirror alone, the source of light being placed a little more to the side of the patient, and the eye of the observer being approximated to within one or two inches of that of the patient. A large erect image is thus obtained, in which all the more minute changes produced by disease can be advantageously studied. The degree of myopia or of hypermetropia can be approximately determined by noticing whether the details of the fundus can best be seen with a concave glass placed behind the mirror, or with a convex one; and the number of the glass which gives the most distinct image is nearly that which the patient requires to use.

HEALTHY APPEARANCES.—(1.) *Retina.*—The retina is transparent, and is naturally of a faint purple tint, which can scarcely be said to interfere with the glow of the choroid seen through it. The retinal vessels radiate from parent-trunks—the central artery, *a c* (Fig. 632), and vein, *a b*, issuing from a central point in the optic nerve. The arteries show some features of distinction from the veins. An arterial trunk has a more direct course, is of smaller calibre, and of a brighter red colour, as compared with the adjacent vein. No pulsation can be detected on simple inspection, but pressure on the globe elicits a distinct pulsation, both in the arteries and veins. The sight, in this state of the circulation, may remain unimpaired. The fovea centralis, *m*, is the central point of the retina, and, owing to the presence of a little more pigment, is generally recognized as a reddish spot situated in the inverted image, a little above and to the inner side of the optic disk, the distance between the two being about two diameters of the disk. Effusion of blood or lymph at this part is always serious, however small it may be in extent, and generally produces permanent impairment of vision.

Fig 632.*



(2.) *Optic nerve* at its ocular extremity—the *Optic papilla or disk.*—This structure exhibits a great variety of appearances, some of which do not affect the sight. The optic disk, *a f* (Fig. 632), has a circular shape; forms a slight projection, as its name implies, but presents a central depression, *a*, termed the physiological cup; and its colour, as compared with the reddish tint of the surrounding retina, is creamy white, or sometimes a pinkish-grey, as in the cortical portion of the cerebral convolutions. The extreme margin of the disk is softly but clearly defined, and is often partially embraced by a thin line of pigment, the presence of which only indicates that the capillary layer of the choroid does not extend quite to the margin of the disk. In some instances, owing to retention by some of the optic nerve-fibres of the sheath of Schwann, tongues or processes of brilliant white colour, striated aspect, and very soft contour project as it were from the disk, and must not be confounded with recent exudation. From the centre of the nerve disk, the retinal artery and vein emerge; commonly, each as a single trunk, sometimes in two or three trunks. The vessels pass off the disk in straight or wavy lines, or sometimes form several abrupt curves on the surface of the nerve before quitting it. As *age* advances, the optic disk deviates from the circular form, becomes smaller in size, and of a darker tint, approaching grey.

(3.) *Choroid.*—The distinctness of this tissue will depend on the

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[*] This figure shows the appearances presented by the fundus of a healthy eye when examined with the ophthalmoscope. The disk, *f*, is seen with a white central spot, *a*, which is the physiological depression or cup, and with the retinal arteries, *a c*, *a d*, and retinal veins, *a b*, *a e*, proceeding from it. At *m*, though much too deeply shaded, is the fovea centralis.

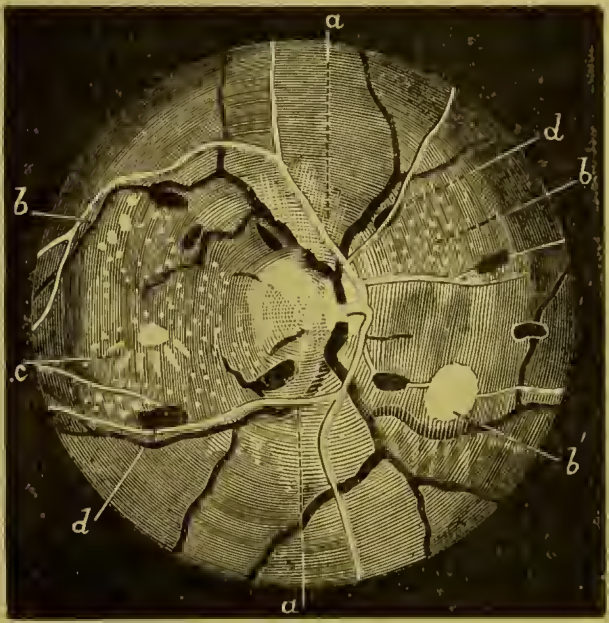
degree of transparency of the retina, and the condition of the hexagonal pigment-cells intervening. The appearance varies also considerably with *age*. Sometimes, in fair and in old persons, and frequently in disease, the large vessels can be clearly seen in consequence of the transparency or atrophy of the capillary layer of the choroid and deficiency of the pigment. They are much larger than the radiating retinal vessels, closely packed with narrow linear interspaces, showing dark pigment. The colour of the choroidal vessels changes during life; at an earlier period presenting a bright red, in old age this colour becomes mixed with a brownish tint. The healthy *choroid*, seen under the ophthalmoscope, presents a uniform, delicately stippled red hue, which is due to the blood contained in its capillary layer. The tint is more or less deep, in accordance with the amount of pigment in the hexagonal cells on the inner surface, connected with the retina, and in the irregular cells that are distributed through its substance. The difference is well seen if the eyes of a blue-eyed, fair-haired Scandinavian are compared with those of the negro; and allowance must be made for this in the examination of the fundus oculi in disease.

(4.) *Vitreous humour*, *aqueous humour*, *the lens*, and its *capsule*, and the *cornea*.—These parts of the eye are transparent in the healthy state, and thus admit of clear inspection of the whole of the posterior portion of the interior of the eyeball. Contrasting with the healthy state, as the standard of comparison, the morbid appearances of the same tissues within this portion of the eyeball have already been described. They remained for centuries unknown, and they never could have been discovered without the aid of the ophthalmoscope. This instrument has, in fact, revolutionized the pathology of deep-seated diseases of the eyeball, and this department of Ophthalmic Surgery.

Morbid Ophthalmoscopic Appearances.—The principal morbid appearances or conditions, as shown by examination of the interior of the eye with the ophthalmoscope, may be divided into those presented by the refracting media and those presented by the tunics. Amongst the more important of the former are—defective transparency of the aqueous humour and lens, the recognition of which may be aided by oblique illumination, and which may be due either to inflammatory or hæmorrhagic effusion, or, in the case of the lens, to the formation of cataract; cloudiness of the vitreous humour, which is commonly the result of choroiditis, attended with the effusion of lymph and blood into this humour. These conditions, if at all well marked, obscure or altogether conceal the fundus. In addition, abnormal conditions in the refraction of the media may, by careful examination, be recognized, and even determined with some approach to accuracy.

The *optic nerve*, at its ocular extremity, may present changes of size, form, and colour peculiar to itself. But very great variations are compatible with good sight. Certain natural changes incident to advancing life are—shrinking and deviation from the circular form, with a darkening of colour approaching to grey. Other changes are morbid, though not necessarily of much consequence in respect to vision. *Black pigment* is frequently seen in the form of a thin line around the optic nerve, to the extent of a sixth or a quarter of its circumference. In disease the papilla may become *hyperæmic*, and of a more rosy colour than natural, which may pass into the condition termed *optic neuritis*. In this the outline of the disk and of the vessels traversing it is obscured; the vision is generally, if carefully tested, impaired, but is sometimes surprisingly perfect. Optic neuritis usually occurs as an accompaniment of Bright's disease, of serious intra-cranial disease, and of syphilis, or, more rarely, associated with diabetes, in all of which it is usually bilateral; but it may also result from the pressure upon the ophthalmic or retinal veins of a tumour growing in the orbit, in which case the term "choked disk" (in German, *Stauungspapille*) has been applied to it, though it is very doubtful whether an accurate diagnosis can be established in life between optic neuritis from constitutional causes and that from pressure. The optic disk, either with or without antecedent optic neuritis, may pass into a state of white atrophy, characterized by the colour and sharp definition. This condition, formerly named *gutta serena*, may result from cerebral disease, from antecedent optic neuritis, from glaucoma, and from embolism of the central artery of the retina. It also appears to proceed from the habitual abuse of alcohol and tobacco, and is generally associated with retinitis pigmentosa. The state of the vessels varies considerably, the retinal arteries and vessels in many instances long retaining their normal size and volume; whilst in the atrophy consequent on embolism of the ophthalmic or central artery, and in the atrophy of retinitis pigmentosa, they are greatly diminished in size. *Pitting*, or indentation of the extremity of the nerve, is often noticed in cases of greatly impaired or lost vision. This concave appearance may either affect the central part only of the disk, in which case it is normal, and has been termed the physiological cup; or the whole of the disk, when it indicates past or present abnormal intra-ocular pressure, a condition that is constantly present in glaucoma. The more important morbid appearances presented by the tunics are—a *dusky halo* around the optic nerve, characteristic of optic neuritis, and commonly attended with general dimness of sight, or *amblyopia;* a *white patch* of variable extent and very irregular outline, immediately surrounding the optic nerve, which is very characteristic of, though not necessarily present in, myopia; *yellowish-white* spots and hæmorrhages scattered over the retina, in dimness of sight with Bright's disease; *black pigment* deposits on the retina; white patches of exposed *sclerotic*, often fringed with a black margin of pigment; *extravasations of blood*, either from the choroid or retina, presenting, after a time, a slight brownish stain, a faint mottling, a linear or stellated cicatricial appearance of a lighter colour than the surrounding tissue. *Serous effusion* between the retina and choroid may occur as a result of acute or chronic inflammation. The acute form of effusion is part of that general disorganization, involving every tissue of the eyeball, which constitutes *glaucoma*. Chronic effusion may exist in such a small quantity as merely to impart a cloudy appearance to a limited portion of retina; or it may have detached a considerable extent or the whole of it from the choroid. Limited effusion is seen frequently in the immediate neighbourhood of the optic nerve; appearing as cloudy greyish patches in the midst of healthy tissue, the radiating vessels spread over the rest of the fundus being lost at the edge of the patch. Alteration of focus will bring these vessels into view over the patch. A large extent, or almost the entire retina, having become detached by effusion, exhibits an opaque greyish surface, or the whole fundus of the eye; which contrasts with the reddish reflecting surface of any undetached portion of the retina. The ophthalmoscope has been of much service in enabling an accurate diagnosis and prognosis of the diseased conditions of the choroid to be made. Unhappily the treatment in many cases can scarcely do more than arrest the progress of the affection, the damage already done being irreparable. Atrophy, hæmorrhages of greater or less extent, inflammation attended by exudation and displacement of the pigment, and ruptures are of not unfrequent occurrence; in rare instances sarcomatous and other tumours have been observed. In myopia the optic disk is usually embraced on its outer part (internal as seen in the inverted image) by a white crescent, due to a protrusion of the sclerotic—which is here rather weaker than elsewhere, and yields to the intraocular pressure—shining through the atrophied layers of the choroid.

Fig. 633.*



One of the commonest forms of retinal disease is albuminuric retinitis. It is seen in patients suffering from Bright's disease and scarlet fever, and occasionally during pregnancy. Attention is generally drawn to the affection by the complaint of the patient that the vision of both eyes is slowly becoming impaired. On examination, optic neuritis is usually found to be present; the disk is swollen, reddish, and destitute of any well-defined limiting contour, so that its position can only be recognized by the point of emergence of the vessels. The arteries are small and indistinct; the veins are large, congested, and often varicose, and, as a result of their over-tension, rupture is not infrequent, causing limited ecchymoses; white spots and irregular-shaped patches are also commonly seen, especially near the posterior pole of the globe. These are partly due to effusion of lymph, or the diapedesis of white corpuscles from the vessels, and partly to fatty degeneration of the retina.

Amaurosis.—This term, signifying simply dimness of sight, proceeding perhaps to total blindness of one or both eyes, is thus far a functional condition; but the loss of vision is dependent on, and symptomatic of, various structural changes in the retina or choroid, the optic nerve or brain. Some such changes, therefore, are open to examination with the ophthalmoscope, while others are concealed and must remain hidden within the cranial cavity.

Symptoms.—Dimness of vision is the essential symptom in amblyopia and cerebral amaurosis, but experienced and manifested in various ways. Coming on suddenly or gradually, and sometimes better, sometimes worse, there may be a general indistinctness of vision—*amblyopia;* or objects appear double—*diplopia;* or half only of an object is seen—*hemiopia;* or objects appear bent, disfigured, discoloured, or patched. Distances cannot be estimated, and therefore the individual misses his aim in trying to snuff a candle, or pour wine into a glass. The flame of a candle appears split, elongated, or scattered into a brilliant halo. *Ocular spectra* of various kinds make their appearance; sparks, flashes of phosphorescent clouds, or dark spots—muscæ volitantes—may be seen when the eyes are turned towards light-coloured surfaces. *Great intolerance of light*, or perhaps longing for light, is sometimes experienced.

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* The appearances met with in albuminuric retinitis: *a*, ill-defined disk; *b*, on the right of figure, minute white spots; *b*, on left of figure, enlarged vein; *d*, arterial hæmorrhages; *c*, *b'*, white spots.

These subjective appearances or sensations may be premonitory symptoms of amaurosis.

The pupil is generally dilated, except there be intolerance of light, and the iris is sluggish or motionless. Both eyes may be affected, and equally or unequally; or one eye may be wholly blind, while the sight of the other is perfect. Similar differences are found in the degree of mobility and dilatation of the pupils. Defective motory power in the muscles of the eyeballs or lids sometimes coexists. The individual, therefore, gropes about with an uncertain gait, his eyes having a vacant stare, and the lids seldom moving or almost fixed.

Examination with the ophthalmoscope can alone determine and complete the diagnosis.

Causes.—The causes of amaurosis are various, and relate either to the nervous or vascular portions of the optic apparatus, or to both. Thus, over-stimulation and *exhaustion* of the retina, by long-continued exertion of the eye on minute objects, or by exposure to glaring light; *anœmia;* or *determination of blood* to the head, as from any stooping occupation or intemperance; or amaurosis may be consequent on *inflammation* or *degeneration*, the *pressure* of extravasated blood, of tumours, or aneurism; or arise from *injury*, as fracture with depression, or concussion, severally affecting the retina, optic nerve, or brain. Besides these local causes, amaurosis may be symptomatic of irritation in a *distant* organ or part —sympathetic amaurosis—*e.g.*, from disorders of the digestive or urinary organs, irritation of the fifth pair of nerves, as by tumours or carious teeth; or sometimes it results from *blood-poisoning*—*e.g.*, in uræmia or diabetes, or by lead, nicotine, alcohol, or belladonna.

Treatment.—Many morbid conditions of the retina and choroid, or further and unknown states of the optic nerve and brain, being associated together, but which have nothing in common with each other, excepting the symptomatic state known as Amblyopia, or dimness of sight, etc., there can be no special treatment of this visual affection. It must differ according to the particular *cause* of the affection.

The removal of the cause can be accomplished only by having due regard to its nature. Any amaurotic occupation may be discontinued, whereas a structural change will probably be permanent and incurable. Remedial measures—also having reference to the particular condition of amaurosis—pertain chiefly to an atonic state, nervous or vascular, hyperæmia and inflammation, sympathetic irritation, and blood-poisons. The treatment with reference thereto must be conducted on ordinary principles.

GLAUCOMA.—An inflammatory condition, apparently, and which gradually involves every tissue of the eyeball; results in its complete and permanent disorganization, with total blindness.

Acute Glaucoma.—The sight is rapidly lost. The attack of the disease, which is more common in women than in men, is often preceded by certain premonitory symptoms,—the most marked of which are the occurrence of sparks and flashes of light, of luminous wheels, and expanding circles of flame before the eyes; the appearance of coloured haloes round candles or gas-lights; the occurrence of fogs or clouds, either obscuring the field of vision generally or limiting its area, so that only central vision is retained; pain extending along the course of one or more of the branches of the first or second division of the fifth pair of nerves; headache, rapidly increasing; presbyopia; increased tension of the globe, and shallowness of the anterior chamber, with sluggish and dilated pupil. The attack commences—usually in the evening—with severe pain in the eyeball, redness of the sclerotic and conjunctiva, and mistiness of sight. The *pain* soon assumes an acute and neuralgic character, piercing through the ophthalmic division of the fifth nerve, and radiating even to the second and third divisions. In a few hours, the iris has acquired a slaty disclouration, and the pupil becomes irregular in form, dilated, and quite immovable. In a day or two the cornea loses its brilliancy, the conjunctival epithelium appearing minutely granular. The eyeball is singularly tense and of *stony hardness;* and the slightest pressure aggravates the pain. Sight is lost by this time, possibly within a few hours, and so completely that even a bright light cannot be perceived. One eye only may be attacked, but frequently the other eye follows in a variable period—one, two, or several days.

The period of life is usually past middle age; and some break-down of the general health or mental anxiety seems frequently to have predisposed to the attack.

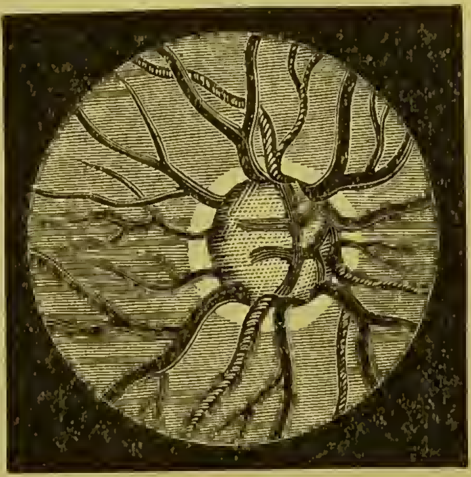
Chronic Glaucoma.—The eye has undergone the same structural changes, only in a more confirmed and conspicuous state. Thus, the tension and stony hardness of the eyeball is greater, and the vascularity of the sclerotic more pronounced; it being marked with faint dusky patches, and sometimes a slight vascular zone, and traversed by large purple tortuous veins emerging abruptly close to the margin of the cornea. *Opacity* of the *lens* is present in many instances; this body has also a full swollen appearance, as if it had undergone maceration, and were almost bursting through its capsule; its *colour*, moreover, has changed to a greyish or greenish drab, dirty yellow, or dull orange tint. This greenish or glaucous aspect of the lens, appearing as it were a reflex tint from the fundus of the eye, was formerly regarded as essential and peculiar to the disease Glaucoma.

The order of *sequence* of the morbid changes would seem to be—congestion in the retina and choroid, continuing perhaps to effusion between these two structures. Hence, pressure on the vitreous humour, and bulging forwards of the lens and iris; followed by congestion and inflammation of the iris and cornea, the lens becoming opaque as a result of its impaired nutrition. Sight is lost, certainly as to the perception of objects; sometimes the retina is even insensible to light.

The disease, in its chronic form, is of insidious origin and slow progress; advancing, with intervals of cessation, during months or years. It occurs in persons beyond middle age, and who have a pale, worn appearance.

The granular condition of the corneal epithelium, and the haziness or complete opacity of the cornea, in acute Glaucoma, preclude in general any examination of the fundus of the eye by means of the ophthalmoscope. Usually, nothing more can be discerned than a faint reddish glow from the retina, without any traco of the optic nerve or retinal vessels. Whilst the disease is threatening, however, and after it has subsided, very important and characteristic features are presented. In subacute and chronic Glaucoma not only is the intra-ocular tension greatly increased, but the point of entrance of the optic nerve, being the part least capable of resistance, is pressed outwards and the disk becomes *cupped.* (Fig. 634.) This condition is recognized by attention to the course of the vessels. If a vein be traced up to the margin of the cupped disk, it will be found to terminate abruptly with a rounded and somewhat darker extremity, due to the vessel bending away from the observer; and the rest of the vessel may then be traced along the floor of the cup formed by the optic disk, and not always continuously with the knuckle at the edge, but shifted, owing to its curving slightly as it descends the hollow to one side or other. The veins often pulsate.

FIG. 634.*



Treatment.— *Acute* Glaucoma may succumb to prompt antiphlogistic measures—cupping, counter-irritation, and constitutional treatment, as perhaps that for rheumatism or gout. Opium may relieve the pain. *Chronic* Glaucoma is altogether beyond the reach of any such treatment; the structural disorganization cannot be prevented, it having already taken place, more or less completely.

Iridectomy.—This operation was proposed by Graefe, in 1857; and it has proved more successful than any other mode of treatment. When performed for the cure of Glaucoma, a large portion, or about one-fifth, of the iris should be removed; the proceeding adopted being such as has already been given on pp. 212, 213. The "intra-ocular pressure," on which the whole state of the eye depends, is thus at once relieved, and the Glaucoma *cured.* When, however, complete structural disorganization of the eye has taken place, evidently the operation must be unsuccessful. If iridectomy instruments be not at hand, Mr. Hancock's operation, or simple puncture of the eye in the ciliary region with a cataract-knife, may be practised.

SHORT-SIGHT, and LONG-SIGHT.—These conditions represent exclusively the *range*, not the power or clearness, of vision. They depend on alterations, either in the refractive power of the transparent media of the eye, as an optical instrument, or in the adaptive power of the organ; in either way, the focusing power of the eye is altered. And such alteration is of an opposite character in the two ranges of vision.

The general principles by which errors of refraction can be recognized and treated, may be stated with succinctness and applied with facility; but their complete exposition would require detail, for which the student must refer to treatises specially devoted to the diseases of the eye, and which are unsuited to such a work as the present on account of their rarity.

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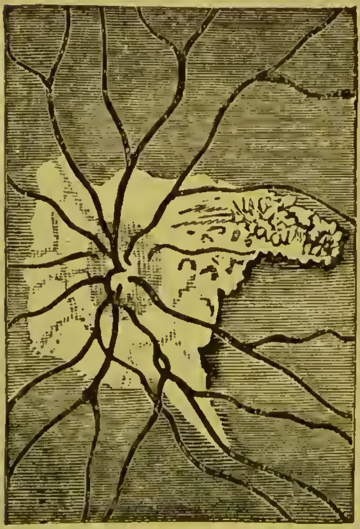
* The cupped disk characterizing glaucoma.

A healthy eye—termed *emmetropic*—is one in which the structure and arrangement of the refracting media is such, that parallel rays are brought to a focus on the retina when the accommodation of the eye is at perfect rest. Any deviation from this condition is termed *ametropia.* If, the accommodation being still at rest, parallel rays are brought to a focus in front of the retina, *myopia* is present, or, in other words, the patient is short-sighted; if behind the retina, *hypermetropia* is present, or the patient is long-sighted. (See Fig. 636.)

There is yet another error of refraction, termed *astigmatism*, in which parallel rays of light, falling in one meridian of the eye, are brought to a focus sooner than in another. The form of hypermetropia which is associated with flattening of the lens and impairment of accommodation, and which is concomitant with advancing age, is termed *presbyopia.*

Myopia.—In myopia, parallel rays of light—that is to say, rays of light proceeding from a distant object—are brought to a focus in front of the retina. The image of any such object is dim and confused, because the rays have already been collected into a focus, and, having crossed, form a circle of diffusion on the retina. A healthy eye is rendered myopic, when a convex glass is placed in front of it. On the other hand, a myopic person sees near objects with clearness, because the rays of light proceeding from such objects are divergent, and are consequently not brought so soon to a focus. Hence, the higher the degree of myopia, the nearer to the eye does the patient hold an object to see the details distinctly. Myopia is usually hereditary, but may also be acquired. It is far more common in Germany than in England, because in the former country the hereditary predisposition is strong; whilst any tendency to it is maintained by the children being more severely tasked, having books the old English type of which is not so legible as the Roman type in use in England, whilst the school-rooms are lighted with a greater regard to economy. These causes are, however, being rapidly removed under Government inspection. In myopia (as shown at N″, Fig. 636), the globe of the eye, which should be nearly spherical, is elongated in the antero-posterior direction. The globe is usually large and prominent; it is firm to the touch. The pupils are large, owing to inertia of the accommodation. On ophthalmoscopic examination, the optic disk sometimes presents the ordinary character, but more frequently is partially surrounded by a brilliant white crescent, termed the myopic crescent

FIG. 635.*



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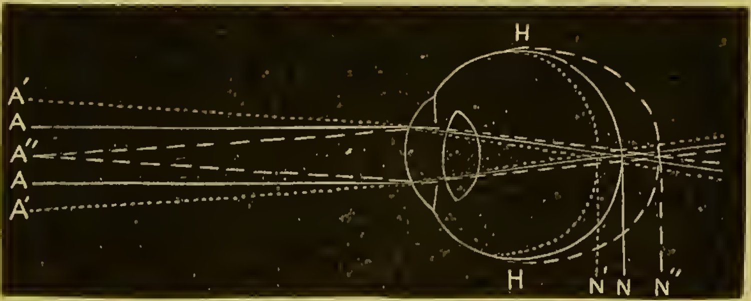
* This drawing shows the appearance, under the ophthalmoscope, of a posterior staphyloma, a condition frequently accompanying myopia.

(shown in Fig. 635), which is the expression of a bulging or staphyloma at this part, leading to retraction of the choroid coat, and to the exposure of the inner surface of the sclerotic, over which the retinal vessels, and sometimes a few remaining choroidal vessels, may be seen with great clearness to wander. This staphyloma generally affects the sclerotic surrounding the outer half of the disk. If, whilst the disk or a retinal vessel is visible with the ophthalmoscope without the lens, the patient is desired to look inward or outward, the disk or vessel will be seen to travel in the same direction; and if concave lenses of various power be placed behind the mirror, an approximative estimation may be made of the degree of myopia of the patient, by observing what power is required to enable the details of any part of the retina to be distinctly seen. Myopic eyes are liable to disease, especially to intra-ocular hæmorrhage, probably owing to the rupture of blood-vessels which have been stretched by the development of the staphyloma. Patients thus affected often complain of muscæ or floating bodies before the eyes, which are due to small blood-clots or particles of lymph; and these are sometimes visible under the ophthalmoscope. Commencing usually a little before puberty, short-sight increases up to about the age of twenty-five, when the form of the eye undergoes no further change. Occasionally, however, it progresses slowly throughout life.

In the *treatment* of myopia, test types or large letters should be placed before the patient, at a distance of twenty or thirty feet; and each eye should be separately tested with concave glasses, commencing with the feeblest, and giving to him the weakest with which he can see distinctly. Concave glasses cause parallel rays of light to diverge; hence, when placed before the eye, they cause the rays to be focussed at a point somewhat behind or further back than the point where they would be focussed if the eye were of normal form. It is obvious, however, that, if too strong glasses are used, the accommodation of the patient must be brought into play to bring these divergent rays to a focus, and pain is the invariable result. Myopic patients should avoid all circumstances that tend to congest the head. They should therefore sit upright; wear no tight collars; read books or play music of good type, in a good light, and held as far away from them as is consistent with good vision; and attend to the bowels.

FIG. 636.*



Hypermetropia—Long-sightedness.—This condition is opposed to myopia, and results from the eye being flattened in the antero-posterior diameter, so that (as shown at N′ in Fig. 636) parallel rays of light are not brought to a focus on the retina, but at a greater or less distance behind it. If the patient desire to see a remote object, he has to exert his accommodation; that is to say, he has to contract his ciliary muscle, which, relaxing the suspensory ligament of the lens, allows the lens to become thicker, and causes parallel rays to be focussed on the retina. But if this be the case with the parallel rays proceeding from distant objects, much more so is it with the diverging rays proceeding from near objects. In order to see a near object, the patient has to exert his accommodation much more powerfully; and the muscular effort required soon gives rise to redness of the conjunctiva, lachrymation, pain, and dimness of vision, the letters of a book running into one another and rendering continuous work impossible. These symptoms are not necessarily associated with hypermetropia. They may exist in an emmetropic eye, if the power of the ciliary muscle has been weakened by general debility. They are not unfrequently seen in those who are exhausted by loss of blood, over-nursing, and fevers, when any attempt is made to work or read. The patient is then said to suffer from "accommodative asthenopia." In some instances, not only is there enfeebled accommodation, owing to want of power of the ciliary muscle, but the internal recti muscles are insufficiently incurvated; and the symptoms above mentioned are produced as soon as the patient begins to read, because he is unable to maintain the convergence of the eyes requisite to look at near objects. In asthenopia dependent on hypermetropia, the selection of appropriate glasses is imperatively required, and will at once remove the symptoms, enabling the patient to use the eyes on near objects for long periods of time without distress.

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* Showing the form of the eye diagrammatically—N, N', N'', being considered the retina—in the natural state, or emmetropia, N; in hypermetropia, N'; and in myopia, N''.

The point to be determined is to select the strongest pair of glasses, which, when the accommodation of the eyes of the patient is at perfect rest, will bring parallel rays of light to a focus. The fact that hypermetropia is present may in general be rapidly ascertained by placing a convex glass of fifty or forty inches focus before each eye: if the patient sees distant objects better, or even as well with the glass as without, hypermetropia may be safely pronounced to be present. The diagnosis may be further verified with the aid of the ophthalmoscope; for, on using the mirror alone, as for the inverted image, but without the lens, if the patient be told to move the eye to the right or left, the image of the disk or of any retinal vessel appears to the observer to move in the opposite direction; and, again, if the ophthalmoscope be used as for the examination of the erect image, the details of the fundus can be clearly made out with a convex lens, the number of the lens affording an approximative estimate of the glass required by the patient. To determine the glass required with any degree of accuracy, however, it is requisite to paralyze the accommodation of the eye; since, in hypermetropic eyes, the ciliary muscle is always strongly developed, and, being always required, is involuntarily brought into play when any object, however remote it may be, is attentively observed. The patient should be directed to instil one or two drops of a solution of atropine, containing four grains to the ounce of distilled water, twice in one day and once the following morning. The pupil then becomes widely dilated, the activity of the ciliary muscle, and with it the accommodation of the eye, is abolished, and there is more or less impairment of vision—the degree of impairment being proportionate to the amount of hypermetropia present. The patient is then placed opposite, and about twenty feet distant from, letters or test types about one-third of an inch in height and breadth, and glasses are successively placed before each eye, beginning with weak ones, and gradually increasing their strength till perfect vision is obtained. The strongest glasses the patient can see distinctly with are finally ordered. In many cases it is found expedient to use somewhat weaker glasses in the first instance, and to prescribe the stronger ones only after the patient has become accustomed to the use of spectacles. In the higher forms of hypermetropia, as well as in asthenopia from insufficiency of the internal recti, it becomes requisite to employ prisms; and, in the latter affection, attention should be paid to the general health of the patient, and all causes tending to produce debility should be removed.

Presbyopia.—This term is applied to the long-sightedness resulting from flattening of the lens. There is loss of accommodative power and retrocession of the near point. It commences about the turn of life,—say fifty; reading then becoming more and more difficult. The book is held at some distance, even arm's-length, from the eyes; and there is as much straining and sense of effort to look at a sufficient distance away from the object, in order to bring the focus forwards to the retina, as in short-sight to look nearer,—thus to turn the focus backwards to the retina. This difficulty of long-sightedness increases as age advances.

Treatment.—Any endeavour to accustom the eyes to the nearer range of former years should be abandoned, as being foolish and prejudicial. *Convex* spectacles must at once be resorted to; the lowest power which may be required being used first, and increased as the sight demands. The *test* of sufficiency in respect to the glasses selected for short-sight or for long-sight is, that the person shall be enabled to see objects distinctly at the average distances of sight, without any magnifying effect or sense of effort.

Astigmatism or *Astigmism.*—This term, and—as Dixon suggests—the latter more correctly, signifies an unequal refraction of the rays of light, in passing through the cornea, whereby they do not all converge to and meet at one point or focus on the retina. This difference of refraction is due to an unsymmetrical form of the cornea, which thus presents different curves of surface, as measured in the vertical, transverse, or oblique directions. Originally described by Young (1801), and subsequently by Professor Airey, each from his own personal experience, Professor Donders has recently shown that this visual peculiarity is not uncommon.

Treatment requires the use of cylindrical or astigmatic glasses to correct the unequal refraction. The glass must be a segment of a cylinder, and when used, it must be adjusted before the eye, vertically, transversely, or obliquely, so as to suit the meridian of irregular refraction. For myopia, a concavo-cylindrical shaped glass will be appropriate; and for presbyopia, a convexo-cylindrical glass.

Test types, in a regularly graduated series of sizes, are employed by ophthalmologists in examining a patient, to determine the power of vision. To insure a uniform standard for observation and the report of cases, Jaeger's numbered series of reading tests, published in 1854, are in general use. Snellen's types, having a regularly proportioned scale of thickness of stroke, are even more accurate.

Faulty perception of Colours.—Colour-blindness—*acritochromacy*—is an inability to discriminate between colours. Various other terms have been devised to designate this defect. It is generally an inability to perceive red, and the compound tints into which this colour enters. Blue is almost always appreciated; and yellow, always. The cause of this defective perception is probably not in the eye itself, but in that portion of the brain to which the impressions of light are conveyed. It is a cerebral affection, but may be temporary. An important practical suggestion was made by Wilson, that persons employed on railways and elsewhere, who are required to observe coloured lights as signals, should be previously tested as to their power of perceiving colours with perfect accuracy.

No treatment can be said to be curative or even palliative.

Day-sight or *Hemeralopia*, and *Night-sight* or *Nyctalopia*, are terms used to designate intermittent blindness, conversely, by night and by day.

Day-sight is perfect in broad daylight, but the power of vision declines after sunset and in twilight. This loss of function is caused apparently by exhaustion of the nervous power of the retina, from exposure to strong sunlight; the weaker stimulus of twilight or moonlight then being insufficient to produce the sensation of light. Hence this deficiency occurs commonly in tropical countries, and in persons who have just returned from long sea-voyages, especially from the East or West Indies.

Rest of the over-stimulated retina would seem to be the most important indication of treatment; coupled with tonics and good food, when toil and hardship have contributed to the exhaustion.

Night-sight, or inability to see by daylight, is not probably a special affection, independently of any inflammatory or other disease of the eye which may be attended with intolerance of light. Scrofulous ophthalmia is thus nyctalopic.

DISEASES OF THE EYEBALL, or of its MOTOR APPARATUS.—(1.) *Protrusion of the Eyeball.*—An unnatural prominence of the eyeball may be unconnected with any disease of the organ. The eyes have a peculiar and painfully staring expression, as if they were too large for the sockets. The lids can be shut, the eyes moved freely in all directions, and sight is unaffected. Both eyes are equally prominent. These peculiarities distinguish this condition from the projection caused by any orbital tumour.

It exists or occurs mostly in women of feeble or hysterical constitution, and would seem to be due to an atonic state of the recti muscles; but the free movement of the eye is incompatible with this explanation of the protrusion. The administration of tonics and the application of electricity to the sympathetic nerve in the neck have occasionally been attended with benefit.

(2.) *Dislocation of the Eyeball*—from its socket—can scarcely take place without rupture of the optic nerve, allowing the eye to be thrust out upon the cheek. Lodgment of the upper eyelid backwards, behind the greatest convexity of the globe, has occasionally happened.

(3.) *Tumours within the Eyeball, or Orbit.*—Various kinds of tumour are liable to form in this, as in other parts. *Cancer* is, perhaps, the most frequent; *hydatids*, or *exostosis*, are occasional forms of growth; and *Glioma*, or perhaps *Myxoma*, may also be met with.

The *diagnosis* of an intra-*orbital* growth will be difficult, and perhaps impossible, at an early period; and still more so, its nature. All give rise to gradual displacement and protrusion of the eyeball. The anterior portion of an intra-orbital growth can sometimes be examined with the tip of the finger between the orbit and the globe, in this situation. An encephaloid cancer-growth, or an hydatid cyst, presents a feeling of elasticity and fluctuation, and by a fine puncture sometimes the true nature of the mass is discovered. Exostosis appears as a tumour of bony resistance. Glioma may grow from the retina, or from the perineurium of the cerebral nerves; the tumour advances inwards into the vitreous humour, or, separating the retina from the choroid, at length protrudes forwards from the ball of the eye. It is of slow growth, but may attain to a considerable size, as a tumour of soft or of a hard consistence. Myxoma, springing from the neuroglia or delicate connective tissue of the nerves, presents a tumour in the vitreous humour, of variable size, but always of soft, mucous consistence. An intra-*ocular* growth will probably be shown by the ophthalmoscope. At a subsequent period of growth, the nature of the tumour may be partly determined by its progress. Encephaloid tumour, and the melanotic variety in particular, progresses most rapidly; exostosis, most slowly. When the eye has burst, the kind of tumour may be declared; as, for example, a fungoid melanotic tumour.

Treatment.—No medicinal treatment has any more controlling influence over an orbital or ocular tumour, than in respect to the same kind of growth situated elsewhere.

The operation of removing a morbid growth from the *orbit* implies a previous exact diagnosis, as to whether it involves the eyeball, and is limited to the orbit or extends into it from the cranium. Such diagnosis will mostly be impossible. In performing the operation of extirpation, any injury to the globe or optic nerve must be most carefully avoided; another difficulty, if not impossibility.

Removal of the Eyeball.—*Partial* removal.—Non-malignant disease, and occasionally destruction of the eye, by or in consequence of injury, are the conditions which may justify excision of the anterior portion only of the organ, with a view to afterwards introducing an artificial eye.

No particular directions are requisite for the performance of this operation. The removal of a staphylomatous projection of the cornea or sclerotic, by means of a cataract-knife, sufficiently illustrates the operative proceeding. The eye collapses, the sclerotic case left shrinks into a nodule, forming the base of support, and when tenderness has ceased, an artificial scale eye is introduced between the lids.

Extirpation of the Eyeball.—Removal of the whole eye should never be resorted to while any sight remains in the organ; *excepting* for malignant disease, or when the irritability of a partially disorganized eye threatens to affect the sight of the other eye, sympathetically.

The operation is best performed as follows:—The patient reclining, and under the influence of chloroform, an incision is made from the outer commissure of the lids backwards, to a sufficient extent just to gain free access to the globe; the lids are then held well apart by retractors in the hands of an assistant. By passing the knife from the incision to the inner commissure, above and below the globe, carefully avoiding any exposed portion of either lid, the conjunctiva is entirely divided, with the ocular attachment of the levator palpebræ and other surrounding muscles. Then, seizing the globe with hooked forceps and drawing it inwards, the knife enters the orbit externally; the eye is detached, the optic nerve and artery are divided at the apex of the orbit, and the attachments severed internally, thus completing the extirpation of the organ. The lachrymal gland should be removed also; it is commonly involved in disease of the ball, and is always useless, or its presence would occasion inconvenience afterwards, as I have noticed by a continued secretion of tears overflowing the cheek, but which at length ceases. Hæmorrhage must be arrested by sluicing with cold water, and the application of a graduated compress, well placed upon the artery at the apex of the orbit. The eyelids are closed, and a light bandage drawn round the head, covering the other eye.

Opiates will have to be administered from time to time, to relieve the severe penetrating and clasping pain in the head. The compress may be removed in about two days, according to the probability of hæmorrhage, and not reapplied unless it should recur. The orbit is to be gently syringed, the wound cleansed, and water-dressing applied, or other dressing on ordinary principles of treatment.

Strabismus, or Squint.—The pathology and causes of Squint have already been noticed in connection with Deformities of the Face (Vol. I. p. 831). It remains only to here describe the operation for its cure or relief.

Fig. 637.*

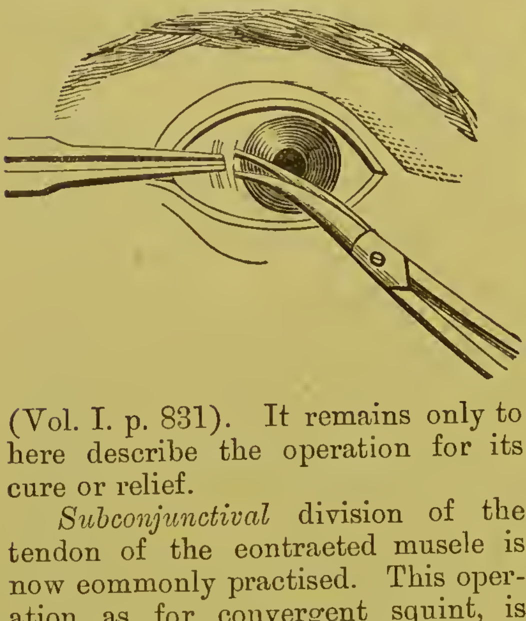
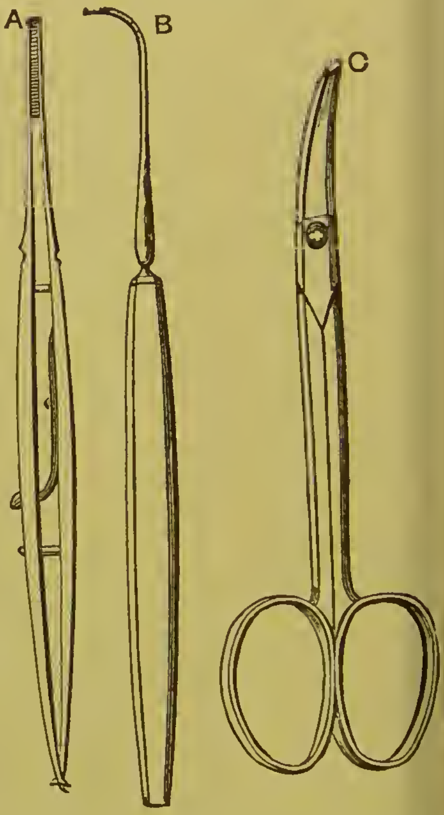


Fig. 638.†



Subconjunctival division of the tendon of the contracted muscle is now commonly practised. This operation, as for convergent squint, is thus performed:—"The lids," says Mr. Dixon, "are kept asunder with a spring speculum; and an assistant draws aside the globe, by nipping up with the forceps a little fold of loose conjunctiva near the margin of the cornea, at the opposite side to that on which the muscle is to be divided. Supposing the internal rectus to be chosen for operation, the Surgeon, with scissors, divides the ocular conjunctiva either vertically, close to the margin of the cornea (Fig. 637), or horizontally, on a level with the lower edge of the cornea, extending the incision towards the semilunar fold. Then he snips through the subconjunctival tissue, and having clearly exposed the sclerotic, slides upwards, between it and the rectus, the hook. (Fig. 638B.) This serves to raise the muscle and make its fibres tense, and then, with curved scissors (Fig. 638C), the muscle is carefully cut through, close to its insertion into the sclerotic. (Fig. 639.) This section of the muscle cannot be completed at a single stroke, but requires repeated use of the scissors, so that no fibres may be left undivided. A careful exploration with the blunt hook or director must be made, to detect any undivided fibres, before the spring speculum is finally withdrawn."

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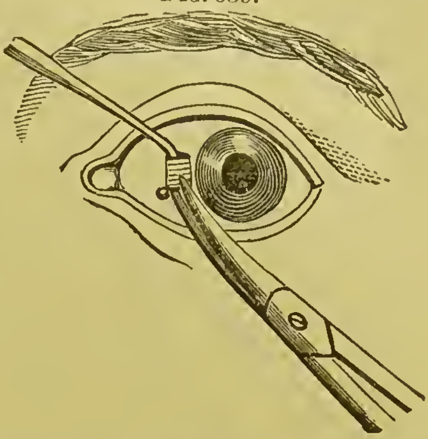
* First step of operation for strabismus—a fold of the conjunctiva, near the border of the cornea, seized and about to be divided by the scissors.

† A. Fixing forceps; B. strabismus hook; C. curved blunt-pointed scissors.

FIG. 639.*



The advantage of this improved mode of operation is, that it prevents the deformity arising from retraction of the semilunar fold, which presents a most conspicuous sort of cavity at the inner corner of the eye, almost worse, in appearance, than the leering cast of squint. The instruments required are fewer: no sharp hook, or the multiplicity of curious little knives, formerly used and abused.

Graefe's operation consists in dividing the conjunctiva a little below the equator of the globe and a few lines from the cornea, almost over the insertion of the tendon; then, exposing the sclerotic just enough to pass a curved blunt hook beneath the tendon, which is drawn well into the conjunctival wound before using the scissors. It is then snipped through close to its sclerotic attachment.

The advantage of this method is, that the tendon is brought quite into view, and is, therefore, not likely to escape division, which is one of the dangers of the subconjunctival operation.

Division of each internal rectus is generally requisite, even when inversion of the better eye is comparatively slight. If the squint be wholly confined to one eye, the single operation will be sufficient.

In dividing the *external* rectus, it should be remembered that this muscle is broader than the internal rectus, and is also inserted farther back from the corneal margin.

Chloroform, in operations for strabismus, is convenient for the purpose of steadying the eye; but it prevents the Surgeon ascertaining whether the muscle has been effectually divided by requesting the patient to attempt inversion, or eversion, of the eye.

After-treatment is very simple. A pad of wet lint may be placed over the eye, and retained by a bandage. In a few hours, when the risk of ecchymosis—"black-eye"—has ceased, this dressing may be discontinued; and the eyes at once brought into use, especially for distant objects.

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* Second step of the operation for strabismus. The tendon is seen raised on the hook, and about to be divided by the scissors.

CHAPTER XLIV.[*]

AURAL SURGERY.

In treating the subject of Aural Surgery in a work devoted to general practitioners and students, it has been the aim of the writer to give as concisely as possible only the leading principles for the diagnosis and treatment. This branch has been so highly developed by the work of Wilde, Toynbee, Gruber, Politzer, etc., that those who desire to make a special study of it have ample means of doing so. But every general practitioner should have at least sufficient knowledge of the subject to treat the more ordinary cases, and to detect those diseases which are beyond his management, and require the advice of a specialist, before irreparable mischief has taken place. With this object the affections which do not require much special training for diagnosis have been more fully dwelt upon.

Malformations.—Congenital malformations of the ear are not unfrequently met with. The auricle and meatus may be entirely absent, but are more frequently imperfectly developed; the former being deformed, or represented merely by a fold of integument, and the latter partially or entirely occluded. Sometimes there is a double set of organs; and in other cases, in which the auricle may be perfect, there is no membrane,—the meatus being closed at the end by skin corresponding to the cutaneous covering of the meatus, beneath which there is generally found solid bone. The tympanic cavity and ossicles are, in most cases of malformation, only partially developed, while the labyrinth is frequently normal; and, when this is the case, there is a

FIG. 640.[†]

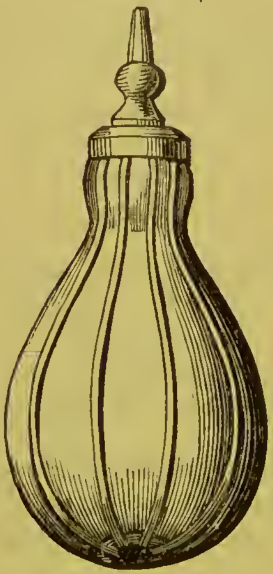
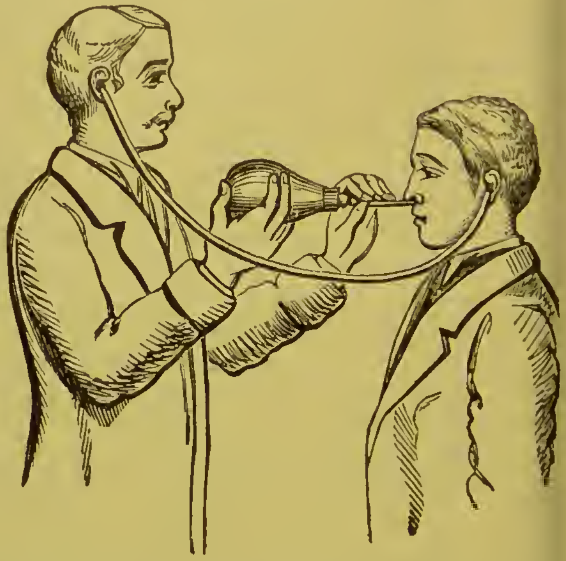


FIG. 641.[‡]



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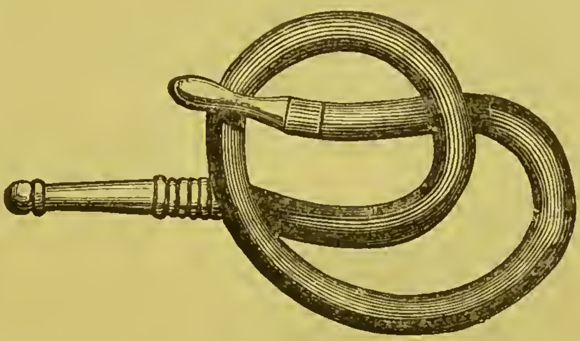
[*] By William Laidlaw Purves.

[†] India-rubber bag used in Politzer's method of opening the Eustachian tubes, or for opening them through the catheter. (Gruber.)

[‡] The figure represents the method of auscultation used when driving air through the catheter and Eustachian tube into the left tympanic cavity. (Gruber.)

certain amount of hearing power. Operative measures in cases of congenital malformation should only be resorted to where, by placing a tuning-fork in contact with the mastoid process or teeth, it is determined that the labyrinth and its connection with the sensorium is fairly healthy. The point of operation may sometimes be determined by passing a current of air through the Eustachian tube, and noting the point at which the impingement of air is heard best. This is accomplished by using what is called Politzer's method, which consists in passing the soft nozzle of a caoutchouc bag (Fig. 640), filled with air, into one or other nostril of the patient with the right hand, while with the fingers of the left the Surgeon compresses the nostrils so as to prevent the exit of the air through them. The patient then swallows a mouthful of water, while at the same time the Surgeon forcibly expels the air from the bag. (Fig. 641.) The air, finding no other passage open, rushes through the Eustachian tube into the cavity of the tympanum, so inflating the membrana tympani. This sudden rush of air against the drum the Surgeon hears by means of an india-rubber tube (Fig. 642) passing from the meatus of his own ear to that of the patient. In young children, the current of air enters the Eustachian tube without the action of swallowing being necessary. In cases of absence of the meatus, the stethoscope may be used in order to determine at which point the air impinges most forcibly, and at this point the opening must be made. If hard or bony, the trephine will be necessary; if soft, a knife will suffice. A crucial incision is made, and kept patent by the introduction of tents or other foreign bodies. Should no membrane be found on cutting down to its usual position, it is advisable to allow the artificial opening to close again. These congenital anomalies are often associated with hare-lip and cleft palate, and generally occur on one side only. Toynbee thinks that they are also accompanied by a peculiar square shape of the face, the lower jaw being very short. Cases in which the meatus was closed by a false membrane have been successfully operated upon by division of this structure and the subsequent introduction of tents. Other cases, in which there was merely a contraction of the orifice of the meatus, have been considerably benefited by the constant use of a tube fitted into the orifice, or by the excision of a portion of the cartilage.

Fig. 642.*



Cutaneous Affections.—*Eczema.*—The auricle is liable to be attacked by a variety of skin affections, such as eczema, impetigo, herpes, pemphigus, and erysipelas, which should be treated as the same affections are treated in other parts. The most common of these—eczema—may occur in either the acute or the chronic form; the characteristic symptoms being, in the auricle as in other parts, moistness, redness, heat, tension, blebs, fissures from which a watery fluid exudes, and the crusts formed by the exudation when the ear is not kept properly clean. The whole of the auricle may be affected, or only a portion of it.

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* Toynbee's diagnostic tube, or otoscope, used in auscultation of the ear to convey the sound from the ear of the Surgeon to that of the patient. (St. John Roosa.)

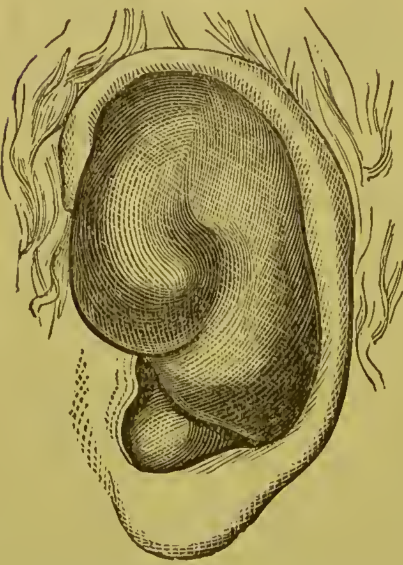
Eczema generally occurs in persons of a debilitated constitution, in strumous children, and in women past the middle age, and is sometimes brought on in the lobe by the puncture that is made for the insertion of an earring. If it has lasted for a long time, as it often may, it leaves a permanently deformed auricle. When the external meatus and membrana tympani are involved, it may leave a permanent diminution of the hearing power, from thickening of these structures.

The course of *treatment* I have usually adopted is to remove by syringing with hot water, and teach the patient how to remove, any accumulations in the meatus, and, after drying it thoroughly, to cover the affected parts with a coating of diachylon ointment, which is kept on for twelve hours. It is then washed off and the parts firmly rubbed with flannel, or, in the case of the meatus, with a roll of cotton wool on a pair of forceps. A lotion of sulphate of zinc (three grains to the ounce of water) is then applied, and when this is dry the plaster is again applied as before, the whole process being repeated every twelve hours. Any neighbouring part should be carefully treated, irritating hair ointments being avoided and the general health carefully attended to.

Injuries to the External Ear do not appear seriously to affect the hearing. They generally do well under the usual treatment, care being taken to adjust the parts as perfectly as possible.

Idiopathic Hœmatoma Auris, or vascular tumour of the ear, commences by a redness of the auricle, with heat and pain, occasionally accompanied by ecchymosis of the conjunctiva of the same side. (Fig. 643.) This is soon followed by an effusion of blood into the concha, which gradually extends over the whole auricle, the natural form being entirely lost. The swelling is usually firm, but fluctuation may be detected. The seat of the disease is always in the cartilage, though the pathological conditions vary in different cases—in some, the perichondrium being separated from the cartilage; in others, pieces of cartilage being found attached to the perichondrium. Sometimes the cartilage is thicker, though no harder than normal; the thickened part presenting no appearance of a cyst, but showing under the microscope hypertrophied cartilage-cells and inter-cellular matter. This cartilage may in some places be converted into true bone, containing Haversian canals and well-defined cells. The idiopathic form of this disease, induced by a general disturbance of nutrition, is believed to be peculiar to patients suffering from or threatened with insanity, and is most common in general paralysis, melancholia, acute and chronic mania, and dementia.

FIG. 643.*



It is as yet undecided whether the pathological changes which occur in this idiopathic disease are the same as those which occur when its origin is traumatic. *Traumatic hæmatoma* is common amongst boxers, and is unquestionably present where there are neither hereditary history nor symptoms of insanity present.

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* Representation of a hæmatoma auris. (Gruber.)

Various modes of *treatment* have been recommended by different authorities. Gruber recommends the evacuation of the fluid and blood by incisions, followed by the use of a compress-bandage; while Wendt relates a case in which the tumour refilled twice after incision, but was cured by lead-water applications and compression. Others recommend the introduction of a seton through the tumour, keeping up a slight discharge; but the application of astringent lotions and a compress is more simple, and appears to be as effectual as any other method.

Besides the othæmatomatous, the auricle may be the seat of *fibro-plastic, fibro-cartilaginous, sebaceous, erectile, epitheliomatous, and sarcomatous tumours.* These tumours are recognized and treated as in other parts of the body.

Gouty Deposits.—In persons of a gouty constitution, deposits of urate of soda are often found in the auricle and meatus. When occurring in the auricle, they are usually seen on the upper border of the helix, and vary from the size of a pin's head to that of a pea. Unless causing an excessive irritation in the meatus, they do not interfere with the hearing power, and are rarely brought under the Surgeon's notice.

Examination of External Meatus and Membrane.—Before proceeding further with a description of the diseases of the ear, it is necessary to make a few remarks upon the examination of the meatus and membrane. The orifice of the meatus can, in a good light, be well seen without the aid of a speculum, by drawing the tragus forward with the one hand, and slightly elevating the helix with the other. For examining the deeper parts of the meatus, or the membrana tympani, a speculum and mirror are almost always necessary. Sunlight, when it is available, is the most satisfactory method of illumination, as it gives the tints of the meatus and membrana tympani more truly than any artificial light; but where it cannot be obtained an Argand burner is a good substitute. There are

Fig. 644.[*]

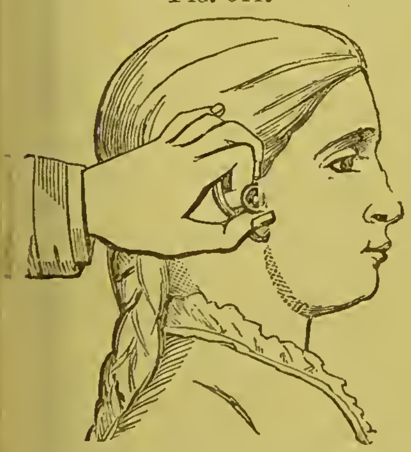
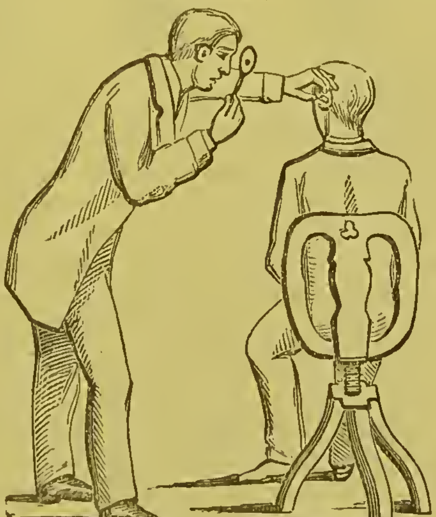


Fig. 645.[†]



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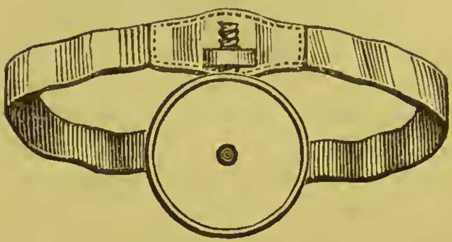
[*] Represents the method of holding the speculum when introduced into the ear. (St. John Roosa.)

[†] Represents the method of examination of the membrane with the aural speculum and concave mirror. (St. John Roosa.)

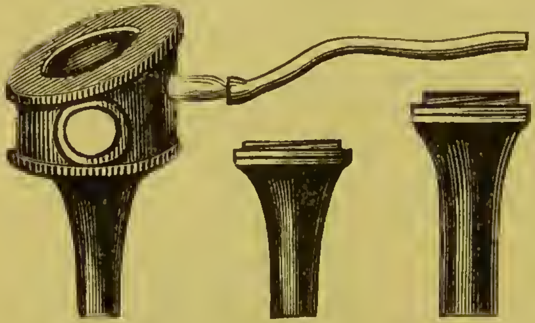
several forms of specula, of either silver or caoutchouc, but the silver speculum of Wilde, with the edge of the narrower end rounded, will be found as convenient as any. (Fig. 644.) This should be of a suitable size, and introduced carefully, as in many patients the meatus is extremely sensitive. The ear to be examined should be turned away from the light, the light being reflected into it by a mirror, which may be worn attached to a band fastened round the Surgeon's head, or held in his hand, as he finds most convenient. (Fig. 645.) A concave mirror, with a hole in the centre and a focal distance of from four to six inches, throws the best light. (Fig. 646.) Siegle's pneumatic speculum, with the addition of a magnifying lens (Fig. 647), is useful for examining the curvature, tension, excursions, and adhesions of the membrane, and is also used for creating a partial vacuum in the meatus, and thus removing fluids from the cavity and destroying newly formed abnormal adhesions.

FIG. 646.*



Diminished Secretion of Cerumen.—A dry condition of the canal, caused by the absence or diminished secretion of cerumen, which is frequently observed in connection with disease of the internal ear, and with nervous deafness, appears to have no influence on the hearing power.

FIG. 647.†



Accumulation of Cerumen.—The accumulation of cerumen in the meatus is caused by either an increased secretion of cerumen, or some obstruction to its natural exit. Irritation, or anything which causes an increased blood supply to the lining membrane of the meatus, will cause an increase in the secretion of cerumen. Accumulations are most frequently seen in old people, in whom the cerumen is stiffer and denser than in the young; in persons who have a narrowing in the calibre, or who have had an abscess in the meatus; in cases of chronic eczema, and in those whose work exposes them to an atmosphere of dust. The masses of wax are usually mingled with dry flakes of epithelium, hairs, and dust. They are usually of a dark-brown or black colour, with a glistening reflection, but in children are pale yellow. The subjective symptoms are tinnitus, deafness, frequently accompanied by pain, vertigo, and confusion of ideas. The mass of cerumen may be in the ear for weeks or months unnoticed, as long as the smallest chink remains between it and the walls of the meatus. The deafness or pain may come on quite suddenly on the complete occlusion of the meatus by a slight inflammatory swelling from cold, or by the displacement of the accumulation or the entrance of a drop of water, which causes the mass to swell quickly. Deafness from this cause is also variable, being frequently better in the morning or after eating.

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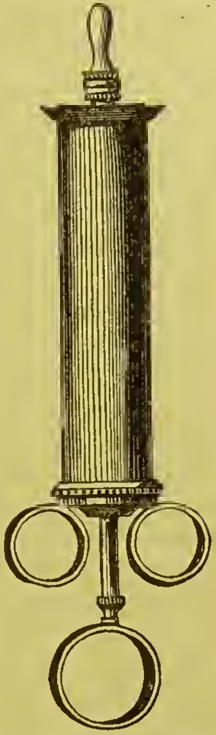
* Concave mirror to be worn on the forehead, for the purpose of reflecting light into the ear through the speculum. (St. John Roosa.)

† A modification of Siegle's pneumatic speculum, with the addition of a magnifying lens for the purpose of examining minute portions of the membrane, and a drum for the determination of the hearing power in different positions of the natural drum. This instrument is used to create a partial vacuum in the meatus. (St. John Roosa.)

In many cases of accumulation of cerumen which are complicated with other aural disease, which may or may not be a result of the cerumen, its removal does not restore the hearing power. If a vibrating tuning-fork, placed on the middle line of the vertex of the head, be not heard better in the affected than in the other ear, there is probably some complication.

If the accumulation can be easily removed with the forceps, without danger of pushing it in against the membrane and without pain, it is well to remove it in this manner, as there may be some abnormal condition of the membrane, in which the forcible injection of a current of water upon it is not advisable. The syringe (Fig. 648), which must be used when it is not found practicable to remove the accumulation with the forceps, should contain from four to five ounces of water; the calibre of the nozzle being from one to two millimètres. A bowl being held by the patient immediately under the lobule of the ear, the Surgeon draws the auricle upwards and backwards; and having passed the nozzle slightly within the orifice of the meatus, a moderately forcible stream of warm water is directed, not against the mass of cerumen, but along the upper wall of the meatus, so as to cause the current to act on the mass while it is passing outwards. Should the accumulation prove hard and tightly impacted, it may require several sittings to complete the removal, between which the patient should frequently fill the meatus with warm water or oil, to soften and loosen the mass.

Fig. 648.*



Foreign Bodies.—Foreign bodies in the ear are most frequently found in young children, who introduce beads, marbles, pebbles, shells, and various other articles of different shapes and sizes, into the meatus. A foreign body which will not swell and has no cutting edge, will generally remain without causing any urgent symptoms; though, should it have a sharp edge, or press on the membrana tympani, it may cause pain, giddiness, confusion, vomiting, cough, anæsthesia, epilepsy, etc. The form of the canal being that of a spiral turning inwards and downwards, with an expansion at either extremity, it is often peculiarly difficult and dangerous to extract foreign substances in any other way than by the injection of warm water. The Surgeon does not frequently see the patient until forcible attempts have been made to extract the body, which have resulted only in inflammation of the canal, and a lessening of its calibre, and have often done more harm than the presence of the bodies themselves. In such cases the inflammation should be allayed by rest, leeches, and fomentations, before any attempt at extraction is made. When the inflammation is subdued, the Surgeon should first assure himself of the presence of the body; for patients suffering from disease of the middle ear often assert that there is some foreign body in the ear, although nothing abnormal is present. He should then determine, if possible, its nature, size, form, and position. When present, it can, the meatus not being narrowed, be seen with the aid of the speculum and mirror, and the probe may then be used to ascertain whether the body is hard or soft, and whether it moves easily or not. In the latter case, it may sometimes be shaken out by inclining the head to the side of the affected ear, or by a sharp percussion with the one hand on the other, which is laid over the ear. But by far the most successful method, and that which carries with it the least danger, is the persevering injection of warm water by means of the syringe, the head being inclined so as to facilitate, as far as possible, the entrance of the water behind the body. Should the latter entirely occlude the meatus, it may be necessary to change its position with the probe before using the syringe. Though this is the safest and usually the most efficient method, it may sometimes, though rarely, fail; in which case some other methods may be employed. Should it be soft, it may be extracted by a hook passed into it from the side; or, should it be too large for that, it may be fixed with a hook, and pieces of it withdrawn with a forceps. Löwenberg's method of bringing a camel's-hair pencil dipped in glue in contact with the foreign body, and allowing it to harden, so binding the body to the pencil, may prove useful in cases in which the body is too hard or smooth for a forceps to have any hold on it, or for the entrance of a hook. If the body cannot be extracted by any of these means, as may (though very rarely) happen, and symptoms of giddiness, pain, etc., become so urgent that the removal in some manner is immediately necessary, the meatus may be entered from above, by loosening the auricle from its superior attachments, or through the mastoid process, the patient being under the influence of an anæsthetic. But such measures should only be resorted to in the most urgent cases.

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* Ear syringe. (Gruber.)

When an animal makes its way into the meatus, its movements against the sensitive drum cause great suffering to the patient. It should be immediately killed by filling the canal with warm oil or glycerine, and then removed with the syringe. Flies are liable to attack the ears where there is a discharge, and the maggots, frequently found lodged on the drum, are difficult to remove. If the drum is perforated, they may be found within the cavity of the tympanum. They must then be removed one by one with the forceps, though the syringe will generally be found sufficient where the drum is entire.

If a vegetable substance is found in the meatus, the Surgeon should not inject fluid unless he has time to effect the removal at once, or within a short time, as, if the substance swells, it may cause unpleasant and even dangerous symptoms, and increase the difficulty of the removal.

The knowledge of the principles of treatment of foreign bodies in the ear is probably the most important part of Aural Surgery to the general practitioner and student. I therefore summarize for their convenience the rules already given, as follows:—(1.) See the body; make sure that there is a foreign body present. This, as a rule, is easily done where there has been no previous inflammation. (2.) Determine what the body is, if possible. Obtain a sample of the body supposed to be in the ear, if one is to be found. (3.) Remember that a body which will not swell, and has no cutting edge, will generally remain without causing any urgent symptoms. (4.) Seeing the body, determine by a probe if it be movable. If easily movable, concussion, with a downward position of the ear, will often remove it. (5.) Warm-water injection is the best of all methods of removing foreign bodies. (6.) If it be a vegetable substance, do not inject fluid, unless you have time to extract the body, either at the one operation or shortly afterwards. (7.) Injection failing, which is very exceptional, a Surgeon with the necessary appliances ought to be at once consulted, as, should urgent symptoms arise from the irritation in the attempted extraction, the extraction by incisions, galvano-cautery, boring out by trephine or conical file the centre of the substance and so causing it to collapse, or even detachment of the posterior attachment of the auricle, may be necessary. (8.) To attempt to extract a substance without seeing it is highly dangerous.

Follicular Abscess, or *furuncle* of the meatus, arises generally in a hair follicle or in one of the ceruminous glands. These often occur as a result of some constitutional affection, and are then associated with boils in other parts of the body. The frequent use of astringent lotions, especially of a solution of alum, appears to place the meatus in conditions favourable to their development, if not the actual cause of their growth. They also occur as complications of eczema, of suppurative disease of the middle ear, where violent syringing has been used or where the disease has not been treated, and of other irritants of the meatus. They are most frequent in middle-aged people. These abscesses appear at first as swellings of various sizes, with broad bases and with ill-defined borders, their colour being scarcely redder than that of the normal skin. The symptoms they occasion are—great throbbing and pain; a feeling of tension consequent on the pressure of the accumulated pus on the unyielding skin and connective tissue; fever in the evening; tinnitus of a knocking or hammering character in the head; and a certain amount of deafness. When occurring at the entrance of the meatus, or in other favourable positions, they are comparatively painless, but when they occur near the membrana tympani the pain is severe. In some cases it is impossible to prevent their recurrence, which may go on for years.

Where the abscess is not fully developed, the treatment consists in arresting its formation. This may be accomplished by painting the swelling with a solution of nitrate of silver (ʒss. to ʒi. to ℥i. of water), or a solution of sulphate of zinc of the same strength. If the abscess is already formed, the pus must be given free exit by incising the swelling according to the usual rules. The formation of a vacuum by means of Siegle's speculum, in order to completely empty the abscess of pus, and to obtain a free flow of blood from the wound, will be found of service. The application of moist heat, by frequently filling the meatus with warm water and laying over it a cataplasm for about half an hour, and, if there is great pain, leeches in front of the tragus, or a roll of cotton saturated with glycerine, must follow, to relieve the patient and bring the abscess to a favourable termination. Constitutional treatment will be required to prevent the development of other furuncles. Mr. Hinton considered that the application of red or white precipitate ointment acted as a preventive.

Narrowing of the External Meatus.—Contractions occur in the bony, as well as in the cartilaginous, portion of the meatus; the latter kind being most frequent in old people, in whom it is caused by a flaccidity and looseness of the fibrous tissue forming the posterior and superior walls of the meatus, which fall forward upon the anterior wall, and thus convert the canal into a slit-like fissure. This narrowing seldom amounts to complete closure, and therefore seldom causes any important degree of deafness, except by forming to a certain extent an obstruction to the natural exit of the cerumen, and thus giving rise to its accumulation. In these cases the hearing is improved by drawing the auricle upwards and backwards, or by the introduction of a speculum; and the patient often finds it convenient to wear a small gold or silver tube in the meatus.

Besides these and the congenital contractions which have already been mentioned, narrowing of the external meatus may arise from thickening of the skin after inflammation, chronic eczema, furuncles, tumours, or the continued use of astringent lotions or ointments. Except in the case of tumours, the canal may be dilated by the use of laminaria digitata or sponge dilators, or by small ivory bougies, gradually increasing in size, and so keeping up pressure on the walls of the meatus and promoting absorption. Any affection of the tympanum which may be present, must be treated, and the canal kept clear of epidermis and cerumen by the injection of warm water.

Exostoses and Hyperostoses.—Exostoses of the meatus are roundish elevations of various sizes, which occur in the bony portion of the canal. They have, usually, broad bases, though they are sometimes pedunculated. The skin covering them is moist and reddened, and very sensitive to pressure. This affection usually occurs in persons who have a tendency to rheumatism and gout; and may sometimes exist after inflammation of the meatus, though more frequently without apparent cause. It is often associated with affections which cause congestion of the mucous membrane of the tympanum, and is more frequent in men than women.

The treatment is unsatisfactory unless the growth is pedunculated, in which case it may be broken off. In the other cases, attention being paid to any other affection which may be present, the application of iodine to the growth itself, and behind the ear to keep up counter-irritation, may diminish its size to a certain extent. Should the meatus be completely occluded, it will be necessary to trephine the exostosis, using tents or styles of lead—the same as used in affections of the lachrymal duct—to keep the channel open for the exit of any pus which may form behind the growth, and for the purpose of keeping those parts clean and of applying medicaments to them.

Hyperostoses usually extend along the whole length of the long portion of the canal, occasionally presenting irregularities. They frequently occur after chronic otorrhœa, being caused by inflammation of the periosteum. The integument covering the bony formation is more or less reddened.

The treatment is that of exostosis.

Syphilitic Affections occur in the meatus, as condylomata and fissures around the orifice, ulcerations of the usual character, and exostoses.

The treatment, both general and local, is of the usual kind.

Aspergilli are most frequently seen amongst the inhabitants of warm or damp climates, especially the Italians. They also sometimes occur after chronic eczema, in long attacks of otitis externa, and in disease of the middle ear. Their appearance, in the meatus, resembles that of "coal-dust blown upon white sand" or fine meal blown into the ear; the tissue beneath being reddened and tender. They are accompanied by severe pain, with tinnitus and deafness.

Many modes of treatment are proposed, but frequent syringing with warm water or alcohol and water will suffice in all cases. If the meatus is not kept thoroughly clean, this parasite may be reproduced in a few hours.

Molluscous or *Sebaceous Tumours* of the meatus are formed by collections of flakes of epidermis enclosed in a membrane. They may occur at all times of life, but are most frequent amongst the old. Though composed of comparatively innocuous material, they have the power of causing absorption of the bone with which they lie in immediate contact, passing through it with a clean-cut aperture without affecting the bony sides of the canal thus formed, and causing symptoms of pressure on the parts beyond. It may be distinguished from exostosis by its being less resistant to pressure.

The treatment consists in laying open the tumour, washing out the accumulated epidermis with the syringe, and withdrawing the lining membrane with the forceps.

Inflammation of the External Auditory Meatus, or *Otitis Externa*, is an inflammatory affection of the superficial integument of the meatus, in severe cases affecting more or less the periosteum, and generally involving the entire surface of the canal and the surface of the membrana tympani. The symptoms are variable in different cases, but at the commencement of the attack the patient usually complains of a continual irritation of the canal, with a feeling of heat and dryness. This passes on to pain shooting all over the affected side of the head, increasing at night and leading to loss of sleep and febrile symptoms. It is increased by every movement of the head, and especially of the jaw. Deafness will also be present in this disease in proportion as the membrane is more or less involved. After this congested condition has lasted two or three days a white watery discharge appears, which gradually assumes a mucous character, this in its turn giving way to a yellow purulent appearance. When this purulent secretion occurs, the pain and other distressing symptoms of numbness and fulness, of which the patient had before complained, suddenly disappear. The affection may now either come to a favourable termination without treatment, or, as is more frequently the case, become chronic, the patient suffering from repeated acute attacks.

On account of the painful swelling and infiltration of the tissues, it is difficult, in examining the ear, to make an accurate diagnosis as to the condition of the canal, especially of the deeper parts; the introduction of the speculum causing pain, particularly about the middle of the meatus, which is peculiarly sensitive. Before the parts can be well seen, the saturated white scales of epidermis and the secretion which is often adherent to the walls must be removed carefully with a syringe or forceps. When a view of the membrane is obtained, it is found, in those cases in which it is implicated (and a Surgeon is rarely consulted before it is so), that the vessels are increased in size and fully injected; or, in a later stage of the affection, the single vessels are no longer visible, the appearance of the membrane corresponding to that of the canal. The angle of demarcation between the edge of the membrana tympani and the walls of the meatus is obliterated, or nearly so, by the pressure of the exudation in the cutaneous tissues. In the chronic form of the disease, there is less swelling of the meatus; here and there are seen macerated spots, often covered with pus, which bleed easily; or brown, offensive crusts, or half-dried secretions. The vessels of the deeper parts and the membrana tympani are observed to be injected. The amount of secretion varies from a moisture scarcely discernible to three or four ounces daily of a yellowish fluid, with an offensive odour, which changes with seasons and other influences. This discharge, when syringed out of the ear, is seen to be milky and flocculent, and may be thus distinguished from that proceeding from the middle ear, which is ropy and stringy, and does not mix with water. Profuse discharge is usually seen amongst children of the lower classes, living in crowded, ill-ventilated rooms, especially amongst those who are not kept clean. If the otorrhœa continues long, it may lead to serious consequences, such as thickening and opacities of the membrana tympani, the formation of polypoid growths, ulceration and perforation of the membrane, and disease of the middle ear or purulent processes in the dura mater and its sinuses. These latter are especially frequent in children, in whom the anatomical conditions favour the transmission of such affections from the tympanum to the cranial cavity. Inflammation may be caused by anything which causes congestion or irritation of the meatus; such as the acute or chronic exanthemata, injuries, the application of heat or spirits to the meatus, the prolonged use of injections of fluid, cold currents of air or water, the presence and the forcible removal of foreign bodies. It may run its course almost unnoticed, or it may become a serious affection. If the purulent stage has not been reached, it terminates usually in from ten to fourteen days; but where that stage has supervened it lasts, generally, from five to eight weeks.

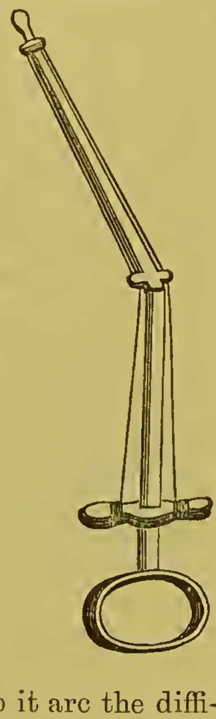
The prognosis in an idiopathic inflammation of the meatus, or one following some not very severe injury, is favourable if it be properly treated; but the secondary form following the acute exanthemata often results in perforation of the membrane.

The *treatment* is etiological. If there is a foreign body, its removal must be the first step. The meatus should be kept free from purulent accumulations, by frequently syringing the ear with warm water, which also allays the pain and irritation. Should the swelling be very great, scarification of the meatus, or an incision, followed by the use of the vacuum speculum, which will promote a free flow of blood, speedily relieves the pain and tension, and causes a subsidence of the thickened integument. This may be also assisted by keeping up a pressure on the circumference of the canal by charpie gently pressed into the meatus, care being taken that the charpie is frequently removed, and the discharge cleared out of the canal. In cases in which the pain is severe, and the patient is too timid to allow of the abstraction of blood by incision or scarification, it is advisable to apply two or three leeches in front of the tragus. A mode of treatment useful in some cases as a means of relieving pain and of giving exit to any secretion which may have passed towards the mastoid process, is that first brought into notice by Sir William Wilde, of incision over the mastoid process. This must be made down to the bone at a distance of from half to three-quarters of an inch from the auricle, the posterior auricular artery being, if possible, avoided. During the painful stage of the affection, sedative solutions, such as morphia (gr. iv. to ℥i. of water) or sulphate of atropine (gr. ii. to ℥i.), may be applied, astringents being used only after the pain has ceased. In the acute form, or in the acute stage of the chronic form, the use of the ordinary astringent lotions, alum, sulphate of zinc, and sulphate of copper, in strengths varying from one to four grains to the ounce of water, or nitrate of silver (from ten to twenty grains to the ounce of water), with attention to any complication which may be present and to the constitution of the patient, are sufficient to insure a favourable course to the disease.

If the chronic form has been reached, stronger solutions of the above-mentioned astringents may be employed, and counter-irritation over the mastoid process by tincture of iodine, cantharides ointment, or some other irritant will be found serviceable.

Polypus.—The formation of a *polypus* usually occurs during some chronic purulent discharge, either from the middle ear or the meatus, and becomes itself a fresh source of discharge, besides increasing the original disease, by preventing the exit of the pus and keeping the parts pressed upon by it in an unhealthy and irritated condition. Aural polypi, usually of a bright red colour, extremely vascular, and bleeding easily on being touched, vary in shape, size, density, and position. They may be grape-shaped, lobulated or ragged, pedunculated or with a broad base. Sometimes they are so large that they protrude from the meatus, in which case they are covered with a hard non-secreting integument, and may almost at the first glance be mistaken for part of the auricle, or a button-shaped outgrowth from it; while at other times they are so small that their presence can be determined only by the most careful examination. The different authorities are not agreed as to which are the most frequent sites of their growth. They arise from the external meatus, from the membrana tympani, or from the cavity of the tympanum; and there may be more than one in the same ear at the same time.

FIG. 649.*



Very small growths, or those occurring in nervous patients who will not suffer removal by instruments, may be removed by the repeated applications of nitrate of silver, undiluted liquor plumbi, alum, or tannin powder,—care being taken that the surface is thoroughly cleaned before each application. But the immediate removal by instruments, whenever it is possible, is by far the most satisfactory and safest method of treatment. Many instruments have been employed for this purpose, the most efficient being Wilde's snare (Fig. 649), Durham's forceps, Hinton's forceps, the knife-hook, and long-armed scissors. Wilde's snare is especially valuable, as it is efficient in almost all cases, and can be introduced through the speculum; and with it there is no danger of injuring the surrounding parts, which may be injured when the polypus is torn out with the forceps. The objections to it are the difficulty of application, and the constant slipping or breaking of the loop after it has been applied. Loops of horse-hair, catgut, and jack-line will be found better than the usually employed wire. In cases in which the excrescence is small, and there is a difficulty in reaching it, the forceps will be found more convenient than the snare. After removal of the growth, some caustic, such as acetic, nitric, or chromic acid, should be applied frequently to the root, until all signs of the polypus have completely disappeared. A convenient method of cauterizing the polypus without injuring the surrounding parts, it being difficult to avoid doing so when a solution is used, is the application of a thin layer of nitrate of silver, obtained by heating a crystal of the caustic over a spirit-lamp and placing a probe or a piece of stout silver wire against the heated crystal; or a fine point of nitrate of silver may be used in a small caustic-holder. When the presence of a polypus is ascertained it should always be removed. Some Surgeons hesitate to remove a polypus where disease of the brain is threatened, on account of the irritation which the removal would cause to the tympanum; but it is probable that its presence is more injurious than its removal, and cases have occurred in which, on the removal of an aural polypus, cerebral symptoms have been almost immediately relieved. After the removal of the polypus the disease, of which it was only a symptom, must be treated.

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* Wilde's snare for the removal of polypus, etc., from the external meatus. (Gruber.)

Injuries of the Membrana Tympani.—Rupture is the most frequent injury that occurs to the membrane. This is caused by the introduction of some sharp-pointed instrument through the external meatus; by attempts to extract foreign bodies; or by a sudden concussion over the auricle, as the blow of the flat hand on the ear or striking the head on the water while bathing, the sudden explosion of artillery near to the patient, or some other loud noise; or as the result of pressure from, or disease in, the meatus or cavity. Rupture occurs more frequently when the ear is already in an unhealthy condition, especially in cases in which an unhealthy condition of the Eustachian tube exists. Artillerymen, in whom this accident is particularly frequent, have a habit of opening the mouth when they expect an explosion of cannon. The effects of a concussion on the membrana tympani are best guarded against by stopping the ears and inclining the ear to the shoulder of the side from which the concussion is expected.

Medico-legal questions occasionally arise as to whether the rupture of a membrane was caused by a blow or was present before the blow was given, or whether the membrane was in such an unhealthy condition that it could be easily injured. The recent rupture of a healthy membrane caused by a blow or a loud explosion is usually a long gaping tear, parallel to the handle of the malleus, the gaping depending upon the action of the radiating fibres of the middle layer. The edges of the tear are coated with blood, the rest of the membrane being healthy, free from opacities, thickening, or deposits, although it may be hyperæmic. A broad, soft, continuous sound is heard with the otoscope, on passing a current of air through the Eustachian tube; unless some time has elapsed since the rupture, in which case infiltration and exudation will have occurred, giving the appearance and the broken and hissing sounds of a diseased membrane.

In a simple case of this kind no special *treatment* will be required, the regenerating power of the membrana tympani being very great. The ear should be closed lightly with a piece of cotton wadding.

Should, however, considerable deafness or tinnitus have arisen from a blow, either with or without rupture of the membrane, the result may be unfavourable, as probably the stapes has been driven into the fenestra ovalis, tearing the ligaments and possibly the membrane and nerve-fibres, and remaining fixed in the window. When the symptoms are such as to lead you to expect a severe propulsion of the stapes inwards, the patient must be kept under treatment for some time before any opinion can be given as to what the results will be. If you can determine by the fork that the acoustic of that side has lost its power, the prognosis is most unfavourable.

Myringitis.—Inflammation of the membrana tympani, though frequently seen in connection with inflammation of the external meatus or diseases of the middle ear, is very rarely a primary affection. When it is so, it usually comes on in the night, after exposure to cold, most frequently after bathing, with severe pain and tinnitus; the pain ceasing as soon as discharge occurs. The membrane is hyperæmic, flattened, and dull, the natural shining appearance being soon lost; while the handle of the malleus is not to be seen on account of the exudation between the layers of the membrane. The meatus, which, in the beginning of the attack is unaffected, soon becomes inflamed about its inner extremity, the line of demarcation between it and the membrane becoming obliterated. In the chronic form of myringitis, which is more frequent, the discharge and pain are so slight, and the affection so little disturbing to the patient, that it may exist for months or even years before a Surgeon is consulted. The membrane appears dull and hazy, yellow or grey in colour, and the handle and short process of the malleus are scarcely visible. It is thickened, and, should there be irregularities in its surface, adhesions in the tympanum are to be feared.

The prognosis in the acute form is very favourable, the disease rapidly recovering under proper treatment; though, if neglected at the beginning, it may lead to perforation of the membrane. In the chronic form, treatment often is continued for a long time before the secretion is restrained; and even then the thickening of the membrane which remains, causes a permanent diminution of the hearing power.

The *treatment* is principally that of otitis externa.

Opacities.—In examining the membrane, the points to be noticed are its colour, transparency, lustre, light-cone, inclination, curvature, entirety, tension, whether adhesions are present or not, and the position of the handle and short process of the malleus. For a full description of these and their anomalies, the reader must be referred to Politzer's "Beleuchtungsbilder des Trommelfells in Gesunden und Kranken Zustande" (Wien, 1865), but a short notice of the changes found in the most common affections of the membrana tympani may be found useful for diagnosis. Abnormal thickening and opacity of the epidermic

Fig. 650.[*]

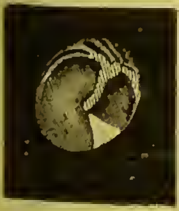
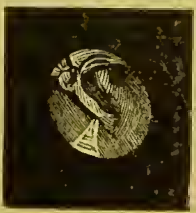


Fig. 651.[†]



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[*] The figure represents the normal condition of the membrana tympani of the right ear. (Gruber.)

[†] Membrana tympani of the left ear in a healthy condition. In this figure the long process of the incus is seen to the right of and parallel to the handle of the malleus too distinctly. (Gruber.)

and dermoid layers most frequently occur after repeated slight attacks of inflammation of the external meatus, extending to the membrane. The transparency and normal lustre are lost, the membrane being of a dirty grey or yellowish colour. This may be distinguished from opacities arising from thickening of the mucous membrane by the clearness with which the handle and short process of the malleus can be seen; for, while a very slight thickening of the epidermic layer renders the manubrium indistinct, a marked opacity of the mucous membrane only does not exclude a view of this portion of the malleus. The opacity last named is the most frequent, as it arises from catarrh of the cavity of the tympanum—probably the most common affection of the middle ear. In the first stages of acute catarrh of the cavity the membrane presents a glistening reddish or copper-coloured appearance, from the congestion of the mucous membrane. This condition does not last long, and is rarely seen by the Surgeon. It soon loses its lustre and becomes dull and grey. In chronic cases, where an accumulation of mucus has been lying long in contact with the membrane, it assumes a yellowish, sodden appearance, like parchment steeped in fluid. The middle layer soon participates in the thickening, and causes the manubrium to be slightly hidden; and should the dermoid layer also become affected, the course of the bone can only be followed by the line of congestion showing the position of the manubrial plexus. Cretaceous deposits are found in the membrana tympani. They may occur in persons whose hearing is normal, but are usually accompanied by a high degree of deafness. They are generally of a crescentic shape, in front of or behind the manubrium; or they may be found in the shape of a horse-shoe, occupying the lower two-thirds of the circumference. They are less frequently seen radiating from the manubrium to the periphery. These deposits are commonly the result of old otorrhœas, the exudation into the substantia propria having calcified. The peripheral opacities of old people, which appear to be analogous to arcus senilis of the cornea, are formed by the infiltration of fatty globules, where the circular fibres are thickest. The changes of inclination and curvature are dependent on closure of the Eustachian tube, adhesions to the walls of the cavity, contraction of the tensor tympani, accumulations of pus and mucus, or tumours internal and external to the cavity, perforations, and thinning or thickening of the membrane. The fact that one eye only at a time is brought to bear on the membrane makes it difficult for the inexperienced observer to judge of its inclination, curvature, displacement, or protrusion.

Perforation.—Perforation frequently occurs after inflammation of the membrana tympani, usually the result of catarrh of the cavity of the tympanum brought on by scarlatina, measles, tuberculosis, or any debilitating affection in which the mucous membranes are involved, of otitis externa, or direct injury. It is one of the most common of aural affections, and is generally easily diagnosed with the speculum; but a perforation may be so small as to be scarcely visible, or, on the other hand, a circumscribed portion of thin membrane, red and sunken, with sharply defined edges, may be mistaken for one. The presence of a perforation may be diagnosed with certainty, if the patient, on being asked to make a forcible expiration with the mouth and nostrils firmly closed, drives the air through the Eustachian tube and tympanic cavity out through the perforation, so that a noise corresponding to the amount of air forced through a perforation of a certain size is heard by the Surgeon—this is called *Valsalva's method;* by hearing the rush outwards of air from a Politzer's bag; or by passing the Eustachian catheter, and hearing the same while forcing a current of air through the catheter with an india-rubber bag or with the mouth. The size of perforations varies from that of a small pin-hole, to an almost entire absence of the membrane; their most frequent position being below and in front of the handle of the malleus, though they may occur in any part of the membrane. Where the greater part of this structure is wanting, or where the perforation is immediately below the handle of the malleus, the aperture is usually kidney or heart shaped, from the projection of the malleus into it. (Fig. 652.) Where the perforation is recent and the acute attack which caused it was short, the prognosis is usually favourable, and the aperture may be completely closed without leaving any discernible pathological change. Such a favourable result is, however, rare after a chronic attack accompanied by otorrhœa, though in some cases, where as much as two-thirds of the membrane are wanting, the aperture may be closed by a cicatrix. The process of healing is known by a gradual diminution of the secretion and of the perforation. The cicatrix is formed of the mucous and dermoid layers, is of a more delicate structure than the natural membrane, and is not separable into laminæ. (Figs. 653, 654.) It is usually sunken, with well-defined edges; and if large, usually presents a glistening reflection, like gold-beater's skin. The hopes of closure are at an end for the time, when the edges of a perforation become cicatrized and an aperture still remains; but a new impetus may be given to the regenerative power by any future affection which causes a hyperæmia of the part and the softening of the cicatricial edges of the perforation.

FIG. 652.[*]

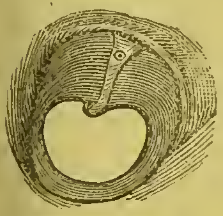


FIG. 653.[†]

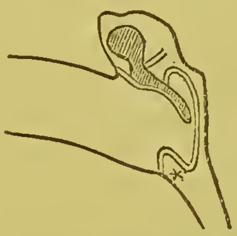
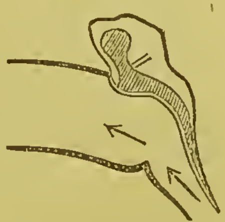


FIG. 654.[‡]



The *treatment* is, as a rule, to close the perforation, if possible; but in most cases of chronic perforation, especially where the aperture is large, the mucous membrane of the cavity, having lost its natural protection and being exposed to cold, dust, air, and other irritants, is in an unhealthy condition, often red and granular, with a chronic discharge from it. In these cases, before the size of the aperture is lessened, the cavity of the tympanum should be got into a healthy condition by treatment; the Eustachian tube being kept pervious by Politzerization, and, if crusts of dried secretion occlude the orifice, by the injection of an alkaline solution, such as bicarbonate of soda (ʒss. to ʒi. to an ounce of water). If the disease has lasted some time, and the larger part of the membrane is absent, the closure of the perforation may impair the hearing power; for this reason it is advisable to temporarily close the aperture with a drop of glycerine or some other thick fluid, and notice the effect. Should the result be to lessen the hearing power to any considerable extent, the patient should be warned of the loss of power which will probably result by the closure, but this should not as a rule deter the Surgeon from trying to obtain a closed cavity. While the affection is in the acute stage, keeping the parts clean with gentle injections of warm water and some mild astringent, for the purpose of restraining the secretion and bringing the membrane into its normal condition, will be all the treatment that is required; the patient at the same time keeping a piece of cotton wadding in the ear when he goes out, if the weather is cold or windy. In order to close a large perforation, the edges should be gently stimulated by the application of nitrate of silver, either in solution or by a thin layer of the crystals on a probe as mentioned in the treatment of granulations, or by some irritant. But if the aperture cannot be closed by the growth of new cicatricial tissue, and yet its closure would improve the hearing power, it may be covered by means of an artificial drum, the success of which is in some cases very great. Numerous modifications of this are used; but the simplest, most easily applied, and best is a piece of cotton wadding moistened in water or carbolic acid solution, and applied over the perforation, lapping considerably over the edges. Another form, which may rarely be found to improve the hearing more than the last, is Toynbee's drum, consisting of a thin disk of vulcanized rubber, projecting from the centre of which is a fine silver wire, by which it is introduced and removed. The effect of an artificial membrane cannot always be judged of by the first application, but it should be introduced several times, changing the point of pressure and adapting it closely against different portions of the remnant of the natural membrane at each introduction, before a conclusion is arrived at as to the amount of improvement of the hearing that it will cause. If it is found to be of service, it ought not to be worn for more than an hour or two at a time for some days. It must always be removed at night, and both the ear and the artificial membrane should be kept in perfect cleanliness.

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[*] Kidney-shaped perforation of the membrana tympani, occupying the greater portion of the membrane below the handle of the malleus. (Politzer.)

[†] Section through the cavity of the tympanum, showing the new membrane which has been formed by the cicatrization of a perforation adherent to the promontory. (Politzer.)

[‡] Section through the cavity of the tympanum, showing the membrana tympani and handle of the malleus adherent to the promontory. (Politzer.)

Artificial Perforation of the Membrane.—This operation is of value in cases of accumulation of pus and mucus in the cavity of the tympanum; of impassable stricture of the Eustachian tube; of thickening of the membrane; of adhesions of the membrane to the walls of the cavity; of relaxed membrane; in cases of obstinate tinnitus, and in those where no benefit has been derived from the prolonged use of other treatment.

That the operation has been of benefit in these cases is certain; though, except where there is an accumulation in the cavity, we can never in any individual case be sure beforehand whether paracentesis will improve the hearing power or not. In cases of accumulation of pus or mucus in the cavity, the operation acts as the opening of an abcess in any other part of the body. In these cases, the operation is performed by means of a small double-edged scalpel introduced through the speculum. The membrane should be punctured, for the purpose of evacuation, at the point at which the greatest bulging is present, while for the other purposes a spot behind the manubrium is usually chosen. The opening having been made sufficiently large, an air douche should be passed through the cavity by one of the usual methods. The operation is easily performed, and generally causes little pain. If the hearing is improved or the tinnitus diminished, and a permanent opening in the membrane is desirable, the Surgeon must attempt to keep it from closing by a bougie, by Politzer's eyelet, by making the perforation with the galvano-cautery, by excising a portion of the malleus with a portion of the membrane, by the constant use of the air douche, etc. But the regenerative power of the membrane is so large that no method that has been tried acts with a certainty of success.

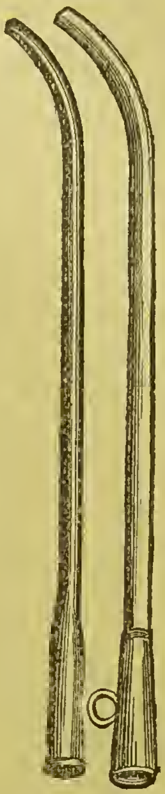
Catarrh of the Middle Ear is the name under which the ordinary affections of the cavity of the tympanum are included. This catarrh may exist in either the acute or the chronic form, the chronic being the most frequent. Acute catarrh is usually brought on by some definite cause, and is associated with catarrhal inflammation of the nasal passages and fauces, or with bronchial catarrh. The pathological conditions are great hyperæmia of the mucous membrane of the middle ear, with an increased secretion; the pharyngeal mucous membrane near the orifice of the Eustachian tubes being almost always affected. The sounds heard through the otoscope (one end of which is placed in the meatus of the patient, the other in that of the Surgeon), when air is passed into the cavity by Valsalva's or Politzer's methods, vary from a harsh dry sound, like that caused by distending a dry bladder, to a true mucous *râle*. At the beginning of the attack the membrana tympani has the appearance of a bright, polished, copper plate; but soon loses its brilliant reflection, and assumes a dull, sodden appearance, from the infiltration of the tissues. The handle of the malleus is plainly visible, except in very severe cases, in which it becomes obscured by the passage of the exudation into the dermoid layers of the membrane. The vessels running over it are then seen to be greatly injected, so that there is a red line in the middle of the membrane. Should an accumulation of fluid have taken place in the cavity on account of the swelling and consequent closure of the mucous membrane of the Eustachian tube, a bulging of the membrana tympani will be observed. The subjective symptoms are intense pain in the ear, which is increased by every motion of the parts, such as coughing or swallowing; diminution of the hearing; a feeling of fulness and pressure in the ear, with tinnitus of various characters, such as singing, hammering, surging; and the patients are often in doubt as to whether these are not sounds originating externally. Added to these are sometimes febrile symptoms, with vertigo, confusion of thought, and other symptoms of pressure. The sub-acute form is a combination of the same symptoms, but in a milder degree.

If the acute form be neglected, it passes into the chronic, which generally, like the acute, involves both the Eustachian tube and the cavity. It may, however, be localized to the tube, or to the other walls of the cavity. This chronic form is most obstinate to treatment, and leads to an increase of deafness, which depends more on the locality of the changes than their extent. It consists in repeated swellings, with thickening of the mucous membrane, which becomes gradually less elastic, leading to adhesions and adhesive bands in the cavity. These adhesions are generally found between the membrane and the promontory, the membrane and the incus or stapes, the tendon of the tensor tympani and the stapes, and especially between the walls of the niche of the fenestra rotunda or the fenestra ovalis—in the former case binding the walls together, and in the latter binding them to the stapes. In a long-standing case of chronic catarrh, the cavity may be almost obliterated by the growth of adhesive bands of connective tissue and adhesions of the membrane, and the stapes may be forced in upon the fenestra ovalis, the pressure of which causes secondary changes in the labyrinth. The ossicula become either anchylosed or immovable from adhesive bands, and the disease leads to almost total deafness. The membrane in these cases is usually found very concave, with patches of calcareous degeneration. The subjective symptoms are a gradual diminution in the hearing power, usually accompanied by increasing tinnitus, which is, in some cases, so harassing that persons have been known to commit suicide to escape from it. The symptoms of pressure are also increased so much that vomiting is somtimes induced. The prognosis in the acute form, and in the chronic form, if the Surgeon is consulted before degenerative changes have taken place to any extent, is favourable; but the treatment is prolonged over such a length of time, that the patient frequently ceases to attend before the disease is arrested. Where degenerative changes have taken place, so that the hearing cannot be restored or even improved, the Surgeon should at least endeavour to stay the progress of the disease, which, if left to itself, will eventually lead to total deafness. The older the patient the more chronic the disease; and the greater the changes which have already taken place in the middle ear, the less chance there is of a favourable result. The prognosis is unfavourable in cases in which the tinnitus is continuous, or where the disease has begun with a slight, but gradually and slowly increasing tinnitus, even though, under treatment, the hearing is improved for a time; and in cases in which an almost total obliteration of the cavity has occurred, especially if there are cretaceous deposits on the membrane, no improvement can be expected.

Where adhesions have not yet occurred in the cavity, the treatment must be directed towards preventing their formation; where they are already formed, we must, if possible, break them up and attempt to restore the parts to their natural position and elasticity. While the pain and hyperæmia are present, local blood-letting may be employed; four to six leeches being applied below and in front of the ear. The after-treatment will consist in the application of the air douche, the injection of medicaments to the Eustachian tube and the tympanic cavity, the treatment of any pharyngeal affection which may be present, and the performance of various operations on the sound-conducting apparatus.

Two methods of passing currents of air through the Eustachian tube into the cavity of the tympanum have already been described. The third, which consists in the employment of the Eustachian catheter (Fig. 655), is especially useful for the passage of fluids or vapours, and for the guidance of bougies, elastic catheters, and instruments for electrical purposes into and through the Eustachian tube. The passage of this instrument is by no means so difficult as is generally believed. The silver catheter, with an obtuse angle of from 110 to 120 degrees, is generally most convenient in the hands of those accustomed to its use. The caoutchouc ones are liable to break after having been used for some time, and, though they are not so likely to make false passages in the hands of an inexperienced operator as the silver ones, they do not convey such accurate knowledge of the position of the beak in relation to the structures over which it passes.

FIG. 655.*



The patient should be placed with the inferior meatus of the nares horizontal and their external openings opposite the right shoulder of the operator, who tilts the point of the nose upwards with the fingers of the left hand, and places the beak of the catheter on the floor of whichever side corresponds to the ear into which it is to be introduced. Keeping the beak close against the floor of the inferior meatus, the catheter is raised to the horizontal position, and then carried in until it reaches the posterior wall of the pharynx, where it gives the operator the same feeling of resistance which he would receive on pressing it against the tense open palm of the hand. He next withdraws the catheter from one-third to three-fourths of an inch backwards towards himself, and slightly elevates its outer end, till he feels the concavity of the angle catch on the floor of the nares. He then revolves it through an angle of a little more than 90 degrees, so that the ring on the catheter corresponding in direction to the beak of the instrument, which has till now been in a vertical direction, is turned upwards and outwards towards the external ear, when he feels the catheter make a slight dip into the pharyngeal opening of the Eustachian tube.

This is the method usually adopted; but in another, which has been proposed by Bonnefont, the operator turns the beak of the catheter from the posterior pharyngeal wall outwards towards Müller's depression, and then he draws it back towards himself, till he feels that it has passed over a swelling and fallen into a depression. In Löwenburg's method, after reaching the posterior pharyngeal wall, he turns the beak of the catheter inwards, drawing it towards him till the curve catches on the posterior edge of the nasal septum, and then revolves it upwards or downwards through a semicircle, when it will pass into the tube. If the beak of the catheter is well into the mouth of the tube, air can be passed through the catheter into the tympanum with an india-rubber bag or from the mouth; and the Surgeon will therefore be able to assure himself that the catheter is properly introduced, by listening with the otoscope for the sound caused by the inflation of the drum.

The mistakes which are most commonly made by beginners in passing the Eustachian catheter are—introducing it into the middle, instead of the inferior, meatus of the nares; and, after the catheter has touched the posterior pharyngeal wall, not bringing it sufficiently forward, in which case it falls into the depression behind the opening of the Eustachian tube. But these mistakes may be easily avoided by attending to the directions given above, keeping the beak close against the floor of the inferior meatus, and taking care to feel the pressure of the curve on the back of the septum or the soft palate, before turning the beak outwards.

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* St. John Roosa.

In children the outward turn of the beak of the catheter is more limited in extent than in adults, in whom it is generally 90 to 128 degrees; but it varies in different individuals. In a new patient it is advisable to try the right side first, as it will usually be found easier to pass the catheter on that side, on account of a general slight inclination of the nasal septum to the left.

If there is any obstruction to the passage of the catheter in the nostril corresponding to the ear in which you desire to pass it, the Eustachian tube may, by using a catheter with a longer curve, be reached from the opposite nostril; or the catheter may be passed from the mouth.

Dr. Weber Liel, of Berlin, has introduced a small elastic catheter, for securing the direct passage of injections into, and removing accumulations from, the cavity of the tympanum. The ordinary silver catheter being used as a director, the small elastic one is passed through it; and having thus, at its exit from the silver catheter, obtained a position in the tube, it is passed on with care through the tube and into the cavity of the tympanum.

The injections passed through the catheter into the middle ear consist of preparations of potass, ammonia, iodine, mercury, silver, zinc, atropine, chloral, etc., in solution. Care must be taken that the fluid injected is always lukewarm.

The following solutions are most generally used, but are not recommended, as much damage is caused frequently by the direct injection of fluids into the cavity:—Sulphate of zinc (in strength varying from one to ten grains), muriate of ammonia (five to twenty grains), iodide of potassium (ten to sixty grains), iodine (one to five grains), chlorate of soda (five grains to the ounce of water). The injections passing directly on to the tympanum, through the elastic catheter, should be much weaker. Before using the solutions the Eustachian tube should be cleansed of mucus or any other removable obstruction which may be present. They should be used every second or third day for from three to eight weeks, after which an interval of a month or more is advisable before renewing their application.

Should the patient object to the use of the catheter, medicated vapours may be applied to the cavity, by means of Valsalva's method, which is as follows:—From ten to thirty drops of equal parts of iodine and acetic ether being mixed in a pint of hot water, the patient closes the nostrils with the fingers and inhales a mouthful of the steam, and then, with the mouth and nostrils firmly closed, makes a forcible expiration. The steam, being thus forced against the walls of the naso-pharyngeal space, rushes up the Eustachian tubes into the cavities of the tympana, causing a sensation of fulness and warmth. This process should be repeated several times at one sitting, the patient performing the act of swallowing between each inhalation, for the purpose of emptying the cavities, before again filling them with steam. Should the Eustachian tubes be closed or rendered impervious by swelling of the mucous membrane, this method will probably not succeed, in which case the catheter must be resorted to, as the passing of a current of air through it from an india-rubber bag will often remove an obstruction which will not give way to Valsalva's method.

The treatment of the pharyngeal mucous membrane, which is almost always affected in catarrh of the middle ear, is an important step towards arresting this disease. It consists in the topical applications of astringents, such as alum, tannin, or nitrate of silver. A useful method of doing this is, to draw a solution of alum up the nostril, allow it to pass back into the naso-pharyngeal space, expectorate it, and then blow air violently through the nostrils. Where alum is not sufficient for the condition of the pharynx, nitrate of silver may be applied in solutions of from ʒss. to ʒi. to the ounce of water. The patient being seated in a good light, and the tongue being depressed with a tongue spatula, he is desired to take a deep inspiration, at which moment the Surgeon passes the brush, previously dipped in a solution of nitrate of silver, back to the opening of one of the Eustachian tubes. He then passes it quickly upwards, over the roof of the naso-pharyngeal space, to the Eustachian tube on the opposite side. Gargles are also of benefit to the membrane, the most useful being preparations of alum or iodine. These should be used by the patient at home, twice a day, between the applications of the caustic.

The nasal douche is recommended by Professor Gruber and others, but must be used with caution. This consists of a syringe, the nozzle of which fills one nostril, while the other nostril is closed by the fingers of the operator. A current of some astringent solution is injected by the syringe up one nostril and so into the other, the obstruction to its exit from the other nostril by the fingers regulating the force with which it acts on the pharyngeal walls. But this method is not safe, except for those accustomed to its use, as it is so difficult to regulate the force with which the solution acts on the naso-pharyngeal walls with regard to the resistance of the Eustachian tube, that the fluid may pass through it and into the tympanic cavity with a force that may do serious damage.

Operations on the Tympanic Cavity.—The operations performed on the membrana tympani and structure of the cavity are—perforation of the membrane, division of the adhesions, and tenotomy of the tensor tympani. Perforation of the membrane has been already described. The diagnosis and determination of the exact position of adhesions can be made by means of Siegle's pneumatic speculum. The portions of the membrane which are bound down by adhesions, and do not fall forward into the vacuum, can be easily seen. Tenotomy of the tensor tympani is indicated where the membrane is concave and almost immovable; the most favourable cases for its performance being those which are partially relieved by the air douche, but in which a permanent improvement is not effected by that means. This operation and division of the adhesions are performed by means of curved bistouries, or revolving cutting-hooks made for the purpose; but it requires considerable experience in the diagnosis and treatment of aural affections to be certain of the necessity for such operations and the benefit likely to be derived from them.

Otitis Media, or *Purulent Catarrh*, is a higher grade of simple catarrh, in which purulent discharge is mingled with the increased secretion of mucus. The symptoms are the same as those of simple catarrh, but occurring in a more violent degree, and accompanied by severe pain and fever. The prognosis is more unfavourable, this affection almost always leading to perforation; but should an extensive accumulation have taken place, this is to be desired rather than feared; for, should the membrane not give way, which is sometimes the case when it has been thickened by chronic catarrh, the pus is liable to make its way through some of the passages which exist between the tympanum and the cerebral cavities, and cause grave cerebral symptoms. Purulent catarrh occurs in weakly scrofulous constitutions, from injuries or influences which in a healthy person would cause simple catarrh; but it is more frequently the result of the acute exanthemata:—scarlet fever, measles, small-pox, and also typhus fever and phthisis.

While pain and fever are present, leeches should be placed round the ear, the meatus filled frequently with warm water, and opiates and purgatives given. But the most important step in the treatment is to give the pus every opportunity of free exit from the cavity, by natural or artificial channels. The Eustachian tube must be kept open by the use of the air douche, either by means of the catheter or Politzer's bag; and if there is great bulging of the membrane, and urgent symptoms are present, paracentesis will be necessary. When otorrhœa has occurred in consequence of perforation of the membrane, the ear should be frequently syringed with warm water, to which an astringent or antiseptic has been added. The astringent employed may also be made to pass through the cavity and through the Eustachian tube by filling the meatus of each ear with the solution, the patient keeping it there until a current of air is made to pass through the Eustachian, whereupon the fluid in the external canals will rush into the cavity and down through the Eustachian tube; or by injecting it forcibly from the meatus. Constitutional treatment will also be required.

The purulent catarrh of children is frequently unnoticed until serious changes have resulted. The screaming of the child, which is loud and persevering, is increased by every movement of the body, especially of the head; and it at length refuses to suck. These cases seldom come before the Surgeon until the membrane has been ruptured and the pus is escaping from the external meatus. Should the Surgeon see the child before this happens, he may do something to relieve the pain and prevent the destruction of useful structures, by some of the remedies recommended in otitis media, with the free opening of any enlargement over the mastoid process. The principal cause of this affection is scarlet fever, though measles and typhus fever also contribute to the number.

There is a prejudice, amongst both the laity and the profession, against stopping any chronic discharge from the ear by treatment. But this cannot be too severely combated; for, though discharge may be present for a long time without pain or inconvenient deafness, complications—such as polypi, paralysis of the facial nerve, and caries—may occur at any time, and deafness to some extent is almost sure ultimately to supervene.

Labyrinthine Deafness.—The chief symptoms of this class of diseases are great deafness—coming on gradually or acquired suddenly—tinnitus, and frequently vertigo, nausea, vomiting, and pain. When these symptoms are present and the membrana tympani and middle ear are found to be in a normal condition, and the fork is not heard, or very imperfectly heard, when placed vibrating on the mastoid, we may conclude that the case is one of nervous deafness. When such affections are primary, the conditions causing them are believed to be hyperæmia of the labyrinth, or hæmorrhage into it, or inflammation of the labyrinth, which, especially in children, is often mistaken for meningitis. There may also be malignant disease of the labyrinth.

But affections of the labyrinth are more often secondary, resulting from the extension of disease of the middle ear, meningitis, fevers, tumours, aneurism, hysteria, child-birth, over-lactation, anæmia, or syphilis. Except in the case of syphilitic affection, there is almost no hope of recovering the hearing power already lost, but treatment may prevent the progress of the disease. But if a case of hereditary syphilis be brought to the Surgeon before the auditory nerve is affected, immediate constitutional treatment may preserve to the patient at least a certain amount of hearing power. In these cases the syphilitic physiognomy is usually seen; and the choroid is almost always found to be affected where the media of the eye are sufficiently clear for a view of the retina.

Deaf-mutism.—The greater majority of cases of deaf-mutism are congenital; the remainder resulting from fevers, teething, hydrocephalus, convulsions, etc. The pathological conditions usually found in these cases are changes in the cavity of the tympanum, defects in the sound-conducting apparatus, abnormalities in the labyrinth, the auditory nerve, or the cerebrum. Hereditary influences are undoubtedly often present, and deaf-mutism is frequently associated with retinitis pigmentosa. No treatment is possible, except the careful education of the child, and the cultivation of such hearing power as it possesses. If placed in an institution for the education of deaf-mutes, he will be taught to watch the lips of the speaker; and, after careful and laborious teaching, he may be able to learn the formation of syllables so that he can converse.

CHAPTER XLV.

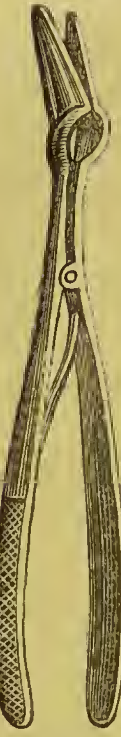
INJURIES AND DISEASES OF THE NOSE.

INJURIES.—(1.) *Foreign Bodies* are sometimes thrust into the nostrils of children in play. Pearl buttons, pebbles, peas, or other small bodies, may thus be lodged a little way within the nares, and easily seen or discovered by slightly dilating the nostril with a nasal speculum. (Fig. 656.) Extraction can generally be accomplished by an ear-scoop, or a bent probe, or with polypus-forceps. Failing to remove the body through the nostril, it must be pushed back into the throat. Sometimes, syringing with warm water will succeed better in washing an impacted substance out, forwards or backwards.

(2.) *Epistaxis*, or bleeding from the nose, may, in common with other hæmorrhages, be the effect of injury, or induced by some state of the circulation or of the blood itself; determination of blood to the head in a plethoric subject producing *active* hæmorrhage of arterial blood; disease of the heart or liver opposing the return of venous blood, or the altered state of the blood in scurvy, purpura, and other diseases, producing *passive* hæmorrhage.

Violent exercises are liable to cause an attack,—as straining efforts in lifting weights, rowing, or running; the act of vomiting or defecation; violent sneezing or coughing. The influence of predisposing causes is witnessed in the tendency to epistaxis among those who lead a sedentary life, and indulge in the luxuries of the table, or bend the head and overwork the brain in some intellectual occupation. Cold bathing, sudden changes of temperature or climate, altitude of locality, with therefore a rarified atmosphere, are the chief external conditions which induce bleeding from the nose. Sometimes, such a discharge is simply vicarious of suppressed menstruation, or of an hæmorrhoidal flux, or of defective perspiration in diseases of the skin; or it may occur as a critical hæmorrhage in the course of various fevers.

Fig. 656.



In young persons, epistaxis is rarely a formidable hæmorrhage, though I have seen such severe recurring bleeding from fracture of the nasal bones—a broken nose, in a powerful policeman—as well-nigh proved fatal. In elderly and enfeebled persons, epistaxis is often perilous.

Treatment.—Slight epistaxis, in young and healthy subjects, may be arrested, when necessary, by sluicing the nose and forehead with cold water, or by cold applied to the nape of the neck; and any tendency to its return prevented by purgatives and emmenagogues. Syringing the nasal fossæ with cold water or an alum solution, or the use of the syphon-douche might, otherwise, be had recourse to. In plethoric persons, to whom epistaxis often acts as a safety-valve, the bleeding should not be indiscriminately checked. Cold, rest, and dry-cupping from the back of the neck sometimes, however, become requisite, these measures being reinforced by saline purgatives. *Passive* hæmorrhage is best controlled by styptics, administered internally and applied within the nostrils. Gallic acid, in five or ten grain doses, is perhaps the most efficient; and the anterior nares may be plugged with a compress of lint or sponge soaked in a solution of alum, perchloride of iron, or tannin. Any concurrent disease, as the cause of hæmorrhage, must of course be treated. A scorbutic condition often yields to the administration of oil of turpentine.

Severe or persistent epistaxis, or as arising from injury, can sometimes be arrested by elevating the arm to a vertical position on the side corresponding to the hæmorrhage; or both arms when the bleeding is from both nostrils. Malgaigne, in his work on Fractures, mentions a remarkable case of copious epistaxis produced by fracture of the nose in the person of a young man who had been thrown down with his face to the ground. Cold lotions having failed to check the hæmorrhage, he was directed to raise his arm perpendicularly; it ceased immediately, and did not recur. But severe or persistent epistaxis will generally require the simple operative procedure of plugging the nares, posterior and anterior, care being taken to ascertain that the hæmorrhage proceeds from the nasal fossæ, and not, as occasionally, from the pharynx behind the soft palate.

Plugging the Nares.—This is most readily accomplished by passing an elastic catheter, armed with a long piece of strong whipcord fastened to its eye end, along the floor of the nasal fossa, through the posterior nares into the pharynx (Fig. 657); then, seizing the cord with forceps as it appears behind the soft palate, it is drawn forwards through the mouth, while the catheter is withdrawn from the nostril. The cord, thus passing round the back of the soft palate, hangs out of the mouth and nose. An oblong plug of lint or compressed sponge, of sufficient size to occupy the posterior nares, is then firmly tied transversely in a loop of the cord as it hangs from the mouth; and by pulling the cord through the nose, the plug is drawn back behind the soft palate into the posterior nares, guided and adjusted by the forefinger of the other hand. (Fig. 658.) The anterior nares is then plugged with a compress of lint or sponge. When, on removing this compress, the bleeding has ceased, the posterior plug can be easily withdrawn by the end of cord which hangs from the mouth. Or the plug may be renewed—a fresh, clean pledget—by means of the nasal end of the cord. Bellocq's sound (Fig. 659) is generally used for introducing the cord, as in Fig. 657, but this instrument may not be at hand; an elastic catheter is surely ready. The plugs should be withdrawn in two or three days, and the nasal fossæ cleansed by injecting cold water, or a weak solution of alum, as an astringent. Septicæmia has followed the retention of decomposing clots.

FIG. 657.

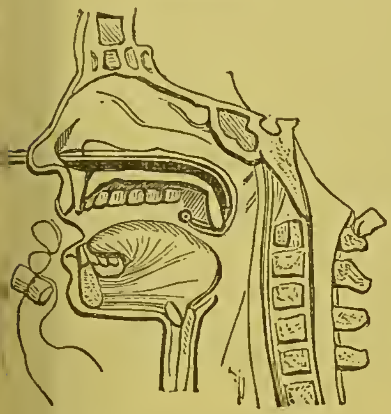


FIG. 658.

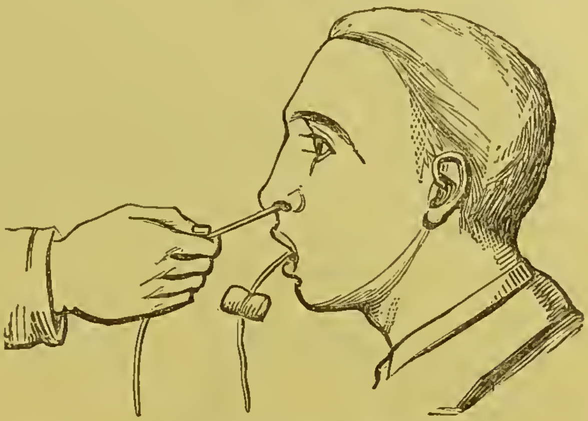
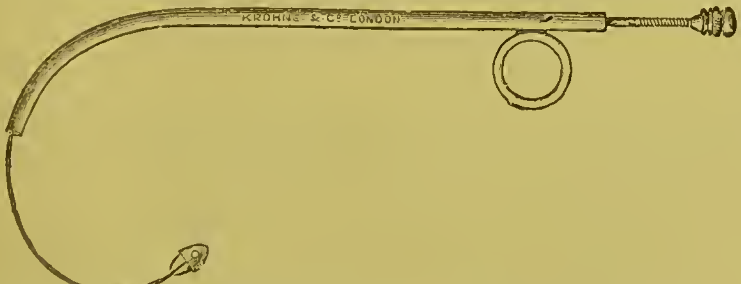


FIG. 659.



DISEASES.—(1.) *Hypertrophy* or *Lipoma.*—An overgrowth of the cellular texture and skin of the nose sometimes occurs, arising apparently from enlargement of the sebaceous follicles, each to the size perhaps of a pea; and which is accompanied with some dilatation of the arterial capillaries, but more so of the veins, and with serous infiltration or fibrinous deposit; thus presenting a large, reddish-blue, and somewhat soft, lobulated, and pedunculated mass at the end of the nose. (Fig. 660.) This inconvenient and unsightly mass is of slow growth and not dangerous; but the monstrous deformity will compel the unhappy individual to seek relief. It occurs seldom before fifty years of age, and in a somewhat broken constitutional state of health.

Removal with the knife is the only remedy, and a tolerably easy one. An incision is made in the middle line of the nose, and the mass carefully dissected off the alar cartilages on either side, an assistant introducing his finger into the nostril to support the cartilage. Hæmorrhage is arrested without much trouble, or a general oozing may be stopped by plugging the nostrils and overlaying a lint-compress, secured by a double-headed roller bandage. The wound usually heals by granulation. Liston removed such growths in several cases, with permanently successful results; in only one instance the operation had to be repeated, for return of the disease after the lapse of ten years.

FIG. 660.*

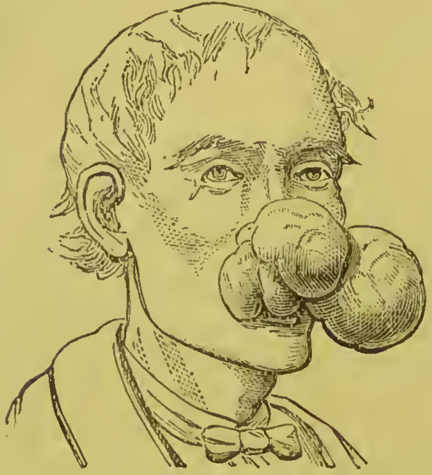
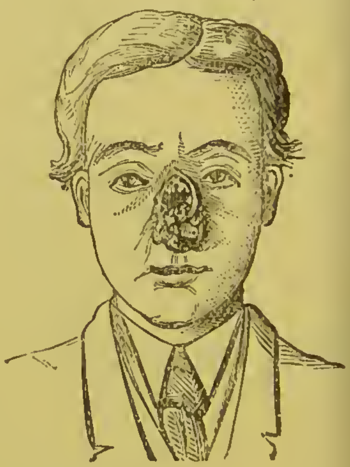


FIG. 661.†



(2.) *Cancer*, occasionally, affects the nose, in the form of scirrhous or encephaloid; but more often as epithelial cancer. These forms of growth present the same appearances as elsewhere. Treatment must be conducted in accordance with general principles.

(3.) *Lupus Exedens*, or *noli me tangere*, seems to have a special affinity for the nose; it is an insidious and obstinate tuberculous ulceration of the skin, and which produces frightful havoc, by the destruction of one or both alæ, the columna, or the whole of the organ (Fig. 661); at length even involving the whole face in one common ruin. If the disease be arrested and cicatrization ensues, the remnant nose appears truncated obliquely from above the nostrils, exhibiting two dark cavernous apertures with a thin-skinned, reddish, shining cicatrix —a hideous spectacle.

The *origin* and *progress* of this disease—with relation to an early and correct diagnosis—may be gathered from the accurate description given by Professor Erasmus Wilson :—Lupus exedens may attack any part of the body, but more commonly the nose ; beginning in the mucous membrane, or in the skin, and in the latter case breaking out upon the tip, the columna, or the ala. It appears as a dull red hemispheroidal papule, remaining for a long time in this condition ; then, uniting with other papules, a *tubercle* is formed, having a smooth surface, which desquamates from time to time, and the tubercle spreads to the adjoining skin. Suppuration takes place at the summit of this tubercle, the pus forming a crust, beneath which the suppuration extends. Or, a crack occurs in the cuticle, exudation follows, and dries up into a thin crust. In either case, when the crust is detached, an ulcer is presented. During this course of suppuration and ulceration, the disease advances slowly to adjacent tissues; the skin becoming red and infiltrated, swollen and tense, suppurative points appear at several spots, with encrustation, and separation of the scabs; thus producing an extensively ulcerated surface. Commonly, the destructive progress of this disease is restricted to the skin; yet not unfrequently, and when active in its course, it involves the deeper tissues, including all the soft parts in the nose, lips, and eyelids; penetrating into the cavities of the nares and mouth, it invades the bones, giving rise to terrible deformity. But the lymphatic glands remain unaffected. Sometimes the disease runs a rapid course, and is very destructive ; it has then been designated by those who delight in the multiplicity of Latin names, *L. vorax*.

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* After Liston. † Royal Free Hospital. (Author.)

Other forms of Lupus exhibit somewhat differential characters. Lupus *non-exedens* also appears as a small tubercle, but of a reddish-yellow or pale amber colour, and semi-transparent aspect; looking like a drop of jelly beneath the cuticle. Such a tubercle is singularly painless and inert ; being attended perhaps with only a pricking or itching sensation, and remaining stationary for months. The cuticle over this tubercle desquamates or cracks, and a little oozing of an ichorous fluid forms a thin brown crust. Fresh tubercles arise around, which unite perhaps into a confluent patch, having a circular or crescentic shape ; and this spreads and enlarges with the circumferential production of other tubercles. The centre of such a patch becomes flattened and depressed, the border receding around ; presenting a white cicatricial appearance. Sometimes, however, the patch breaks up, in parts ; the tubercles subside here and there, leaving clear spaces, with tubercles scattered irregularly over the remaining portions of the surface. Sometimes, also, the tubercular origin of the disease is manifest throughout its course, and sometimes this character entirely disappears. But no ulceration takes place, as in lupus exedens, and less destruction of tissue ; for the disease spreads, not in depth, but through the skin, which is replaced by the gelatinous new-formation ; its absorption leaving a white cicatrix, permanent for life, on a part where no lesion of continuity has occurred, not even an abrasion of the cuticle. The parts attacked are also somewhat different in this variety of lupus ; it usually begins on the cheek or upper lip, perhaps on the lobe of the ear, and less often on the nose. But the resulting deformity, owing to absorption of the skin-substance and the white cicatricial appearance, is often considerable. Thus, the tip of the nose is pointed, and the alæ are drawn up ; the upper lip being raised so as to show the teeth, and the lower eyelids depressed, exposing the eyes. The cicatrix itself has a dead white and polished aspect; its surface lies rather below the level of the surrounding skin, and is beseamed with white ridges or bands. This residuum integument has also lost the natural sensibility of true skin. Lupus *erythematosus* differs in being non-tubercular, as well as in not proceeding to ulceration. Commonly occurring on the nose, or some part of the face, the disease appears as a patch, of small size and irregular shape, but well-defined redness; the centre becomes coated with a dry cuticle, but the patch remains for a long while unchanged; and it terminates in a dry atrophied surface, or in a white depressed cicatrix, resulting from absorption of the true skin beneath the cuticle. This variety of lupus is sometimes associated with the non-exedens, as a sequel of that form of the disease. And similar lupoid erythematous spots may be found on the fingers, looking, at first sight, like chilblains.

The *diagnosis* of lupus, in any form, is important, lest the disease should be mistaken for syphilitic eruptions of a tubercular and ulcerative, or an erythmatous character. But the scrofulous constitution of the patient, with perhaps the co-existence of other strumous affections, will indicate the presence of lupus; while the association of syphilitic affections, coupled with the history of syphilis, would refer the skin-eruption to that disease. This method of diagnosis, by having regard to the constitutional condition, is more certain than any attempt to distinguish the local forms of these two diseases. Lupus is met with, more often, in young persons from fifteen to thirty years of age; sometimes even in children; and more frequently in females. The fair and delicate, or ruddy and healthy, appearance of the strumous patient contrasts, indeed, sadly with the disfigurement which frequently results; but the aspect of youth and beauty differs also from the sallow, wan cachexia of advanced syphilis. The diagnostic characters of the Lupoid Ulcer as compared with those of Cancer Ulcer are described in connection with ULCERS.

Treatment.—Constitutional measures are more remedial than topical applications, in the treatment of any form of Lupus. The general health must be renovated; assimilation and nutrition, more especially, should be improved by means of iron, quinine, iodine, and cod-liver oil—the former medicinal agents being administered in such preparations as may seem to have the most beneficial effect. Thus, the syrup of the iodide of iron, with the sulphate of quinine, are generally the most efficacious; and, in children, the superphosphate of iron is often most valuable. Arsenic may be tried, when other remedies fail; and, when a syphilitic taint is suspected, iodide of potassium, and mercury, may be resorted to with advantage. The hygienic resources of air and exercise, with baths and warm clothing, to promote the circulation in the skin, must never be overlooked. Turning our attention to *local* applications; in the early stage of lupus, as a tubercular affection or an erythematous patch, the disease may perhaps yield under stimulation, conjoined with constitutional treatment. Different Surgeons prefer various remedies; such as a solution of nitrate of silver, ten grains to the ounce; or of cantharides in acetic acid; the benzoated oxide of zinc ointment; or iodine paint. Ulcerative lupus should be subjected to cauterization, freely and decidedly applied to the ulcer. Here, again, various caustics may be used: strong nitric acid, the acid nitrate of mercury, potassa fusa, or chloride of zinc. I employ the latter, mixed with an equal part of flour, forming a paste. Or the Vienna paste is a good preparation; consisting of equal parts of quicklime and potassa cum calce, mixed up with spirits of wine. In using these powerful caustics, and particularly to such a part as the nose or cheek, the surrounding skin must be protected by a piece of plaster, with a hole for the ulcer; and while the zinc paste may be allowed to do its work in the course of six or eight hours, the Vienna compound should be removed after ten or fifteen minutes, as it induces serious constitutional irritation. On removing the caustic, a poultice is applied. In the non-exedens and the erythematous forms of lupus, cauterization is equally necessary; but the destruction of tissue need not extend so deep. Hence, strong solutions of caustic potash will generally answer the purpose.

Restoration of the lost portion of the nose or cheek forms part of the Plastic Surgery of the Face.

Rodent ulcer, as affecting the nose, is allied to Lupus exedens, or perhaps to Epithelial Cancer; and similar treatment may be adopted. This disease is specially described in connection with the general consideration of Ulcers.

(4.) *Syphilitic Ulcer* of the nose differs from the lupoid and cancerous forms of ulcer. It usually attacks the ala or the tip of the nose, and commences as a small pimple, red, hard, and somewhat painful, which suppurates and opens into an ulcer. Sometimes, the skin over the fibro-cartilages inflames and gives way, by a crack or fissure. Thus far there is nothing characteristic. But the resulting ulcer has an irregular, fringed margin. The discharge is ichorous and encrusting; the ulcer, at the same time, eating away beneath. A faint blush surrounds the ulcer. These appearances must, however, be taken in connection with other present or past manifestations of constitutional syphilis, to complete the diagnosis.

The *treatment* is that of secondary syphilis. Mr. Ure found iodide of potassium—when mercury had been previously given—most efficacious, in conjunction with a lotion of bichloride of mercury, a grain and a half to the ounce of water. Under this treatment, an ulcerated patch soon healed, which had extended from the ala to the tip of the nose, and which was of fifteen months' standing.

(5.) *Nævus*, as sometimes met with in the skin of the nose, offers no peculiarities; the vascular growth presents the same appearances as in other parts, and the same methods of removal are available. But it is very desirable to preserve the skin so as to prevent disfigurement. A purplish patch will often yield to cauterization, by touching it with nitric acid; and deeper-seated nævus may be removed by subcutaneous ligature.

Nasal Fossæ.—(1.) *Ozæna* or *Rhinorrhœa.*—A muco-purulent or sanious discharge, having a fœtid odour, yellowish or greenish colour, and coming from one or both nostrils. Proceeding from the mucous membrane lining the nasal fossæ—here named pituitary or Schneiderian membrane—this discharge is symptomatic of various ulcerations of that membrane, involving perhaps the bones forming the fossæ. Thus may be recognized *Catarrhal* Ozæna, which sometimes accompanies chronic catarrh; *Scrofulous* Ozæna; and *Syphilitic* Ozæna. The diagnosis must be mainly determined by the concomitant and antecedent constitutional condition. Impaction of a foreign body in the nasal fossa will at length give rise to an ulcerative discharge. Injury to the nose is occasionally followed by ozæna. One of the worst cases of ozæna I ever saw was the result of contusion of the bridge of the nose, apparently without any syphilitic taint or other constitutionally predisposing cause. The nose often has a broad and flattened appearance —the *nez écrasé* of French authors.

Ozæna commences in infancy or in adolescence, and in either case frequently lasts through life. It has been known to subside when menstruation is established, or after childbirth. But it is rarely cured, excepting at its outset, and that in young subjects.

Treatment.—Various stimulant and astringent applications may be used with advantage to modify the vitality of the pituitary membrane; such as very dilute solutions of nitrate of silver, sulphate of copper, and chloride of zinc. Professor Gross recommends an injection of three grains of tannin with a quarter of a grain of sulphate of copper to an ounce of distilled water. Deodorizing injections must be used to correct the stench; such are chlorinated solutions, and dilute solutions of creosote, carbolic acid, or permanganate of potash. Trousseau extols the insufflation of calomel, conjoined with an injection of bichloride of mercury. In ozœna which has persisted for a period of years, and is attended with superficial erosion of the mucous membrane. Mr. Ure has prescribed with advantage a liniment of fifteen grains of chloride of zinc and one ounce of olive oil, which is to be pencilled over the affected part, once a day. A peculiar caustic-holder has been devised by Cazenove for applying nitrate of silver in ozæna.

Abscess, *ulceration*, *caries*, and *necrosis* in the nasal fossæ, are all intimately connected with ozæna, and scarcely require a separate notice.

Abscess forms most frequently on the septum nasi, and is often associated with a scrofulous taint in the constitution; the presence of an exanthematous fever, as small-pox, measles, scarlatina; or with injury of the integument—a wound situated near the lower end of the nasal bones. The integument becomes œdematous and tender, the pituitary membrane inflamed throughout, and the portion covering the septum is uniformly turgid. Matter forms, and a prominent, red, shining, and fluctuating swelling in one or both nostrils, obstructing the passage. Pain extends up the nose to the frontal sinuses, and the swelling enlarges downwards, protruding the upper lip. Abscess in both nostrils usually communicates through the septum. The *treatment* is simply that of any other abscess. An early incision, and so as to give free vent to the pus, affords great relief. The opening must be maintained, lest the matter reaccumulate. The discharge, at first seropurulent, assumes a glairy consistence. A *cyst*, possibly, in the nasal mucous membrane, or bulging through the thin wall of the antrum, might be mistaken for abscess.

Chronic abscess of the septum is very insidious. Destruction of the bones, cartilages, or both, not uncommonly results, and even after apparent cure of the abscess.

Ulceration occurs in any part of the nasal fossa, but mostly at the angle of the ala and septum, or between the ala and tip. Any such ulcer is very painful and chronic. The *treatment* consists in the application of white precipitate ointment, an excellent remedy; or perhaps citrine ointment or nitrate of silver. General remedial measures must have regard to the constitutional condition.

Various species of Ulcers are met with, occasionally, within the nasal fossæ. Mr. Spencer Watson, in his treatise on Diseases of the Nose, enumerates—erosive Syphilitic Ulcers; Lupoid Ulcer; Eczematous Ulcer; Scorbutic Ulcer; Ulceration in Glanders; in the sequel of Fevers, as measles, scarlatina, small-pox, and typhus; in paralysis of the fifth pair of Nerves; Ulceration of traumatic origin, and from foreign bodies in the fossæ. The diagnosis and treatment of these intra-nasal ulcerative affections form part of the general consideration of the diseases to which they relate.

Caries and *necrosis* may affect any of the bones forming the nasal fossæ; but here, again, the septum more especially, leading perhaps to perforation. The nasal bones participating, a marked flattening of the nose is produced, as the bridge sinks in the course of destruction. Such may be the result of syphilitic ozæna. The only special *treatment* is the removal of the dead portions of bone with polypus-forceps.

(2.) *Thickening of the Schneiderian Membrane.*—This state of the nasal mucous membrane not uncommonly occurs throughout the whole extent of the fossa, and in both nostrils; frequently the thickening or hypertrophy is limited to the portion of mucous membrane underneath the inferior spongy bone. But here the membrane is naturally thick, as Kölliker points out, owing to its glandular character and abundant, almost cavernous, venous plexuses.

Symptoms.—The affection causes uneasy breathing, especially during cold and damp weather; there is also perceptible swelling in the nostril, resembling polypus; but it is of a deeper red colour—never greyish, and not pedunculated. It may also, unlike polypus, be situated on the septum nasi. These appearances were well marked in a case which came under my notice many years ago; and in that instance the lower part of the nose was bent to the side opposite to the thickening, thereby exposing its characters more clearly.

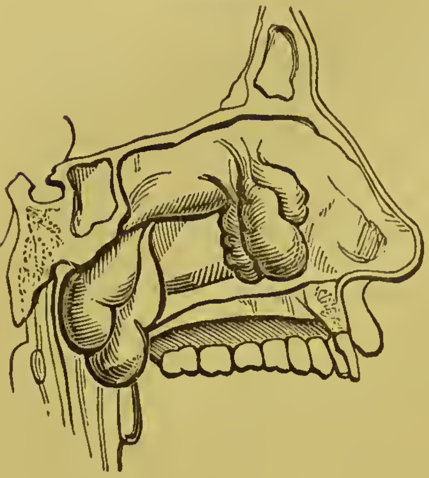
Thickening of the membrane, as thus described, may arise spontaneously, or follow *chronic coryza.* This latter is an inflammatory affection of the Schneiderian membrane, in a chronic state, and distinguished by a thin, acrid, ichorous discharge from the nostrils. It may be catarrhal, or have a syphilitic or scrofulous constitutional origin.

Treatment.—The topical application of astringents, by means of the injections already noticed with reference to ozæna, will probably reduce chronic thickening of the membrane and restrain any coryzal discharge. But these measures must be supported by appropriate constitutional treatment, as also requisite in the various forms of ozæna.

(3.) *Polypus.*—Tumours of very different kinds growing within the nostrils, are associated under the common term "nasal polypi." They agree only in being pedunculated, and as obstructing, more or less completely, the nasal passages. Their structural differences and distinctive characters are as follow.

Gelatinous or *Mucous polypus*—the ordinary form of growth. This is a soft, pulpy, slightly clastic tumour, of a greyish-brown colour, somewhat translucent, and lobulated, attached by a peduncle to the mucous membrane. It consists of the elements of this membrane,—a fibro-cellular texture, having a glandular structure, covered with ciliated epithelium; it is slightly vascular, and more so at the root of the tumour. It is attached, commonly, to the middle spongy bone or middle meatus, extending perhaps an inch from before backwards (Fig. 662); sometimes growing from the other turbinate and ethmoid bones; occasionally from the roof of the nares, or even from the frontal sinuses or antrum; never from the septum. More than one polypus usually forms at the same time; and, several coexisting, each has a distinct peduncular attachment. But the lowest or most anterior readily presents downwards in the open nostril, while the others are concealed and compressed; one overlying another or others, like toadstools in their growth. Polypi may form in both nares simultaneously.

Fig. 662.



The growth increases in size rather slowly and gradually, restricted, probably, by the osseous boundaries of the nares. Occupying, and more or less completely blocking up the passage, the tumour may come forwards to and through the nostril, or extend backwards over the soft palate to the fauces, and hang down into the pharynx. The bones and cartilages seldom become diseased, but displaced; thus enlarging the nasal fossa, and resulting in considerable expansion of the nose. Having a succulent character, owing to its cellular structure, this species of polypus is hygrometric; diminishing in dry, warm weather, and increasing and becoming plump, or even protruding, in moist weather. It may occur at any period of life, but is most common in adults.

The *symptoms* are—a sense of stuffing in the nostril, as if proceeding from a constant cold in the head, and which varies with the state of the weather. A thin mucous discharge from the nose, and fits of sneezing, complete the illusion. Respiration through the nares becomes embarrassed more and more, the patient breathing with his mouth open, and sleeping thus with his head thrown back, snoring loudly. The voice acquires a nasal twang, is indistinct and snuffling; and the special senses, connected with surrounding organs, become affected by the polypoid growth. Smell and taste are impaired or lost. Deafness ensues, due, as Mr. Toynbee states, to a coexistent thickening of the membrana tympani. In addition to symptoms, certain *phenomena* may be elicited. On stopping the free or partially free nostril, by pressing that side of the nose with the finger, the patient cannot breathe through the affected nostril, or imperfectly, the air being expressed by a forcible effort, with a whizzing or singing sound. The patient then feels something shifting its place to and fro in the nasal cavity, and the Surgeon hears a peculiar noise, like, as Dupuytren compared it, to the flapping of a flag. Sometimes the polypus thus descends into sight. On directing the patient's head backwards, the polypus will be seen, or brought into view by dilating the nostril a little with a bivalve nasal speculum; and the tumour is observed to have the characteristic appearances already mentioned. Ultimately, the nose acquires a peculiar broad, laterally dilated, or *frog-faced* aspect; giving a singularly heavy, stupid expression to the upper part of the face.

Diagnosis.—Gelatinous polypus must be distinguished from common catarrhal coryza, from thickening of the mucous membrane covering the middle spongy bone, from displacement of the septum to one side, from abscess of the septum, and from an extraneous body, as a fruit-stone or a nasal calculus. Certain other polypoid growths are also liable to form in the nasal fossa, but these may be diagnosed chiefly by their special characters.

Fibrous polypus presents a firm resistant tumour, instead of a soft, elastic substance like an oyster; and which does not vary in size with hygrometric changes. It is more broadly pedunculated, and springs from the periosteum beneath the mucous membrane. Its structure is essentially fibrous, and much more vascular than gelatinous polypus. Sometimes, according to H. Cloquet, it becomes encrusted with phosphate of lime, and partially ossified. It may spring from the septum, and is usually solitary.

This species of polypus grows more rapidly, attains a larger size, and, owing to its higher vascularity, has a greater tendency to bleed. Increasing in size, the tumour causes greater displacement of the surrounding bones in the nasal fossa—as deviation of the septum, depression of the palate, projection of the nasal bones; or it extends backwards and is prolonged into the pharynx. It is also apt to send offsets into the various sinuses, in the frontal, ethmoid, and superior maxillary bones, thus appearing in situations where little expected, as in the pterygo-maxillary fossa, or in the orbit through an aperture formed in its inner wall.

All the *symptoms* due to the presence of a tumour in the nasal fossa are much more aggravated. The Surgeon should, however, remember the possibility of a polypoid growth springing from within the cranium, the frontal sinus, or the maxillary antrum, and making its appearance in the nasal fossa.

Malignant or *Cancerous polypus.*—This, the third species of polypoid growth, is a soft tumour, of a deep red or dark purple colour, prone to bleed, and painful; fixed to the bone, and springing, perhaps, from a greater depth, within the cranial or sphenoidal cells. The nasal portion may be only the external protrusion of a deep-seated medullary tumour. Growing rapidly, with great expansion of the nostril, it tends to protrude through the nasal or lachrymal bones, and frequently displaces the eye. It discharges a fœtid, bloody, ichorous fluid; while repeated hæmorrhage, and acute, lancinating pains, striking up into the root of the nose and forehead, accompany the development of this species of polypus, and reduce the patient's strength to the last extremity. The disease occurs only in adults or in advanced life.

Treatment.—The three species of polypus, above described and contrasted, are incurable by any known medicinal treatment, whether local or constitutional. Removal by operation is the only resource, but the different species of tumour are thus removable with very different degrees of facility, and probability of non-recurrence.

Gelatinous polypus may perhaps be withered by the influence of astringents; especially powdered tannin, which may be blown into the nostril through a quill, or other small tube. Very rarely, the polypus separates, and is expelled *spontaneously;* and its ejection has been known to happen, after the repeated application of strong stimulant injections, by sloughing of the tumour. But this would be an uncertain and incomplete result, and probably followed by recurrence of the growth.

This species of polypus is usually extracted with *forceps*, by a combined movement of pulling and twisting. Forceps having rather long, serrated blades, to hold securely—nasal polypus-forceps (Fig. 663)—are used for the extraction, the instrument being made of sufficient length, slender, and straight, or slightly curved, according to the situation of the polypus. The neck of the polypus is first clearly ascertained by running a probe round the tumour, above and below the middle spongy bone, or its peduncular attachment elsewhere. Then—the patient sitting facing the light—the Surgeon, standing in front, elevates the tip of the nose with his thumb to gain as good a view as possible of the polypus; he introduces the forceps closed into the nostril, and approaching the peduncle, opens the blades just sufficiently to slide one above and the other below, and securely grasps the peduncle. A little movement of the hand will convey the feeling of attachment, while the soft, yielding texture of the polypoid peduncle, in closing the blades of the forceps, further gives assurance that the spongy bone, a crackling texture, has not been seized. By a gentle pull and jerking twist with the instrument, the polypus is detached and withdrawn from the nostril. Several polypi may successively be removed in like manner, care having been taken to distinctly feel the peduncular attachment before attempting to extract the growth.

Fig. 663.

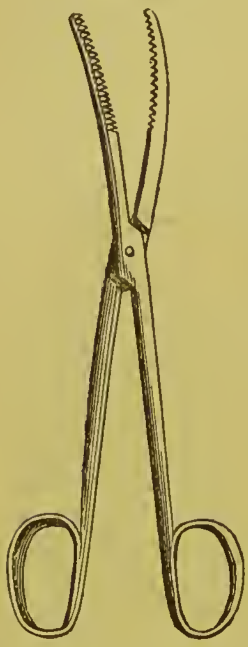
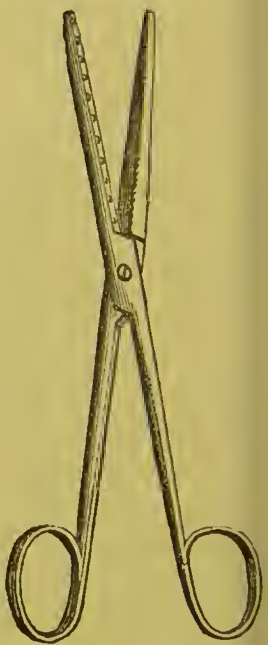


Fig. 664.

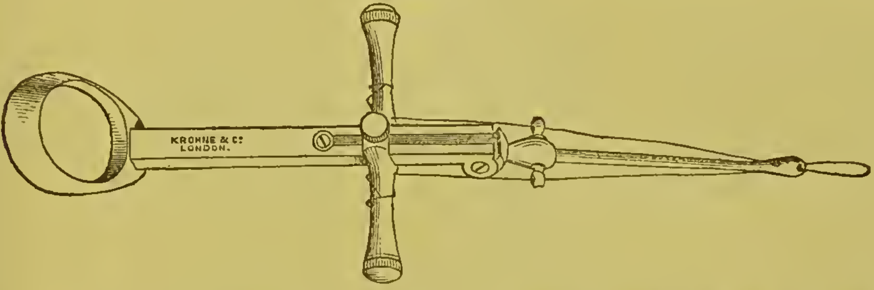


This method of extraction is attended with considerable pain, and not inconsiderable hæmorrhage; the latter often compelling the Surgeon to postpone any further removal of the polypi, to a second and a third sitting. Moreover, even with due precaution in tearing away a gelatinous polypus, its soft consistence yields, and the tumour is apt to come away piecemeal; or the delicate spongy bone or other basis of mucous attachment is liable to be injured, and it has even been urged that the separation of a small scale of bone with the peduncle will more effectually prevent the return of the growth. This is obviously a pathological error respecting the nature of the ordinary mucous or gelatinous form of polypus; and any extraction of bone should be regarded as a misadventure in the operation, which will probably be followed by caries of the exposed osseous surface.

Having regard to all these considerations, the practical importance of which I had often experienced, I, some years since, devised a forceps which cuts and holds the peduncle. The "*polypus scissor-forceps*" (Fig. 664), as this instrument is named, combines scissors and rasped forceps, one edge of either blade being that of an ordinary scissors, the other broad and rasped. This instrument is, in fact, an adaptation of the grape or flower scissors, commonly used in conservatories. By means of the scissor-forceps, I have removed nasal polypi in a large number of cases, with comparatively little pain and hæmorrhage; and never, so far as I have been able to ascertain, has there been any return of the growth, months or years after the operation.

Ligature is chiefly appropriate when polypus passes through the posterior nares, and hangs down in the pharynx—naso-pharyngeal polypus. The object of the operation by *ligature* is to accomplish strangulation, and separation of the polypus in the form of a slough. Accordingly, a loop of firm whipcord, catgut, or silver wire, is passed through the nostril into the pharynx, and expanded under the polypus, and drawn up around the peduncle, this noosing procedure being aided by introducing the forefinger into the mouth. The ends of the cord, at the nostrils, are passed through a slender, double cannula, which is then slid along upon them through the nares to the polypus, when, by tightening and securing the ends of cord to the rings at the nasal extremity of the cannula, the peduncle of the polypus is strangled. The cannula may be introduced threaded with the whipcord, if this seem to be a more easy way of passing the loop. The cord must be tightened, through the cannula, from day to day, until separation of the tumour is effected. Sir W. Fergusson recommends separating the tumour at once, when this can be safely done, rather than allowing it to slough away. Hilton's *snare* instrument (Fig. 665) may be used for immediate strangulation and removal of a polypus, whether within the nasal fossa, or pendent in the pharynx. In either modification of this operation, care must be taken, lest the tumour drop into the lower part of the pharynx or over the larynx, and cause suffocation; and during the process of sloughing-separation, the head should be inclined forwards to avoid the risk of fatal systemic infection from the morbid secretion, a result which has actually occurred.

FIG. 665.



Occasionally, it may be necessary to slit up the ala of the nostril, at its junction with the cheek, in order to gain access to the root of the tumour.

A buttonhole-like incision in the soft palate has been resorted to by Maissonneuve, so as to draw the polypus through the opening into the mouth, where it can be ligatured or cut off with the knife. The direction of the button-hole is from before backwards, and the great elasticity of the soft palate readily allows the polypus to pass through a comparatively small opening, which also generally closes without the aid of suture. This procedure—the *boutonnière palatine*—has yielded the most satisfactory results in the hands of M. Maissonneuve.

A general clearance of the nares has been effected by drawing a plug from behind forwards—a brushing mode of extraction, suggested, I believe, by Dr. M'Ruer, an American physician, who highly extols it. A piece of catgut is introduced, through the nostrils into the mouth, to which is fastened a piece of soft and dry sponge, corresponding in size, when firmly compressed, to the narrowest part of the nasal passage; it is then drawn gently forwards through the nose. In at least ten cases, all the adventitious growths were thus brought away.

Fibrous polypus may, perhaps, be extracted with forceps, or tied when pedunculate. Excision has succeeded in broader-based and larger-sized polypi of this kind.

Cancerous polypus is perfectly irremediable and uncontrollable by any surgical proceeding.

Tumours of the Septum.—Besides abscess of the septum, presenting its characteristic swelling as already noticed, certain tumours, containing blood or of a cartilaginous consistence, are liable to form in the septum nasi. The *bloody tumour* is always the result of injury, and has the appearances of ecchymosis in other parts of the body. Absorption of the extravasated blood should be promoted; incision is rarely necessary. *Cartilaginous tumour* is very uncommon. Mr. Ure met with one such case, and wherein he effected a cure by excision; the junction of the ala of the nose with the cheek having been slit up, in order to make room for the application of a gouge to remove the tumour. A *gelatinous tumour*, of uncertain nature, sometimes forms in the septum. It may be obliterated by snipping away a portion of the wall, and cauterizing the interior with nitrate of silver.

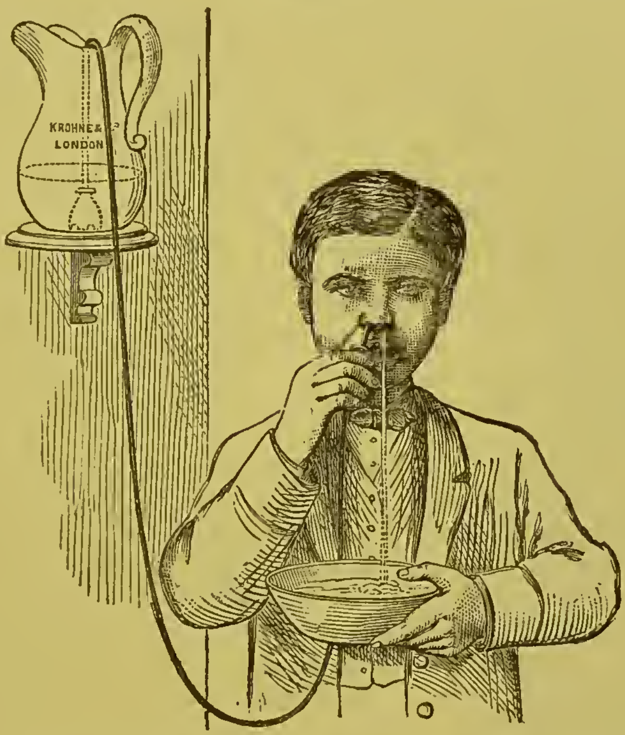
Calculi or *Rhinoliths.*—Calculous concretions occasionally form in the nasal cavities; usually in the lower meatus, or they may originate in the frontal sinus or in the maxillary sinus, and thence pass into the nostril. They vary in size from a date to a hazel-nut, or may completely block up the nares, and produce deviation or partial destruction of the septum. They present an uneven surface, and are of a black, grey, or white aspect. Sometimes single, in other cases multiple, nasal calculi consist of phosphate and carbonate of lime, magnesia, and mucus; resembling other concretions. The nucleus may be an extraneous body, as a cherry-stone, or portion of a tooth. The cause of these concretions is obscure, probably chronic inflammation of the Schneiderian mucous membrane. The *treatment* will, obviously, be the extraction of such bodies by suitable forceps or scoop; and then to allay irritation.

Closure of the Nostrils may be congenital, or acquired as the result of inflammatory constriction or adhesion. The ala of the nose may thus be joined to the septum in consequence of ulceration. Any such impediment to respiration and speech can perhaps be overcome by dilatation with tents, gradually increased in size; or it will be remediable by incision, followed by the use of tents, in the nostril.

Rhinoscopy, or the visual examination of the nasal fossæ, is necessary, in order to gain an accurate knowledge and diagnosis of many diseases to which these cavities are liable, and for the effectual application of topical remedies.

Anterior rhinoscopy, or inspection through the anterior nares, requires some form of instrument for enlarging the aperture of the nostril, the removal of any discharge which might obscure the view, and a good light directed into the nasal cavities. The patient should sit facing the light, with his head well thrown back, while the Surgeon proceeds to make the examination. By placing the thumb on the tip of the nose, and upturning it slightly, the alæ are expanded; and thus the more superficial part of the interior can be brought into view, aided by a little motion of the nose from side to side, as one nostril or the other is inspected. Various *expanding instruments* have been devised for deeper examination. Dr. Thudichum's expanding forceps, or Fränkel's instrument, may be introduced; both of these having the advantage of being self-retentive. Dr. Metz's two-bladed *speculum* admits also of dilatation; while for examining one side of the nose, Mr. Spencer Watson's single-bladed, concave speculum affords a free and illumined view. No expanding instruments should be introduced beyond the cartilaginous boundary of the outer portion of the nose, the only part which can be dilated; and in passing beyond with a speculum, care must be observed, and especially as the vascular mucous membrane is apt to bleed and obscure the view. To remove any discharge or encrusted mucus, the act of blowing the nose may prove sufficient; or it may be requisite to inject tepid water, by means of a syringe, or by passing a stream through the *nasal-syphon douche*. (Fig. 666.) A bleeding ulcerated surface should be cleansed with cold water, or a weak solution of alum or other astringent. The syphon-tube consists of vulcanized india-rubber; the nostril end is provided with lateral apertures, and should fit the nostril. The other end of the tube is placed in a jug of water, elevated above the patient's head, at a height according to the force of the current required. Then, the water having been sucked into the nozzle, this end is inserted into the nostril; when, if the patient breathe entirely through his mouth, the current of water will pass through the nasal fossa, and return on the other side of the septum narium, thence escaping out of

Fig. 666.



the nostril opposite to the entering stream. Both nasal cavities are thus washed by a continuous current. The fluid is prevented from running down into the pharynx by the soft palate; which, according to Weber's observations, effectually closes the posterior nares, as the stream turns round the septum, while the patient breathes entirely through the mouth. To inspect the nasal cavities, *sunlight* is far better than any artificial light, whether from an ordinary lamp, or as the lime-light. The illumination may be concentrated by using a polished reflector, or an ordinary lens.

Posterior rhinoscopy, or inspection through the posterior nares, is accomplished in the same manner as laryngoscopic examination. The patient sitting, his head erect and mouth open, the tongue is gently retracted with a depressor, and the laryngoscope-mirror, set in a long handle bent at the distal end, is then warmed and passed on one side of the uvula, under the arch of the palate, when its reflecting surface is directed upwards and forwards towards the posterior nares. Light is thrown upon the mirror as in laryngoscopy. Thus the posterior nares may be brought into view; showing the middle and inferior spongy bones, and corresponding meatuses, with the median septum of the nares; the openings of the Eustachian tubes, the roof of the pharynx above, the posterior surface of the velum palati below. But the patient must breathe easily, otherwise the soft palate rises and conceals these parts; and in using the mirror, it should be kept free of the palate and uvula, which, when touched, are disposed to contract, and thus interrupt the examination. Previous gargling with cold water may reduce the irritability of the soft parts.

PLASTIC SURGERY OF THE NOSE—RHINOPLASTIC OPERATIONS.—Plastic or Reparative Surgery comprises all those Surgical operations which are designed and performed for the *repair* of deficiencies of structure, —whether resulting from injury, disease, or malformation. It thus represents a large division of Operative Surgery, contrasting with that which pertains to Operations for the *removal* of parts, as by Excision and Amputation.

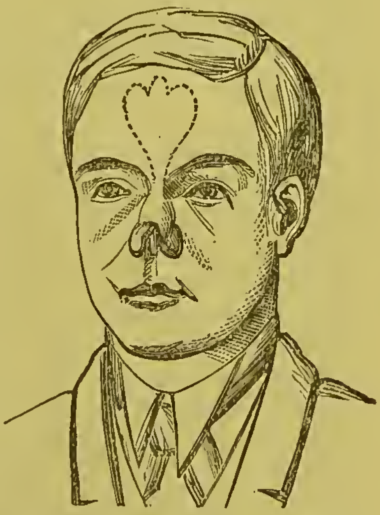
Plastic Surgery is well illustrated by rhinoplastic operations; the repair of structural deficiencies in the nose, as the result of wounds, having almost given rise to all similar operations in respect to other organs; as principally exemplified by the operations for hare-lip and cleft palate, certain diseases of the eyelids, and of the organs of generation. Rhinoplastic operations are sometimes designated Tagliacotian operations, in honour of their originator, Gasparo Tagliacozzi, a celebrated Italian physician who flourished in Bologna, in the latter part of the sixteenth century. After his death, a marble statue was erected to his memory in the anatomical theatre at Bologna, with this insignia of his art—a nose—in his hand. In Italy, and in India, not to mention other countries, mutilation by cutting off the nose has been a common practice, as a punishment for criminals, or for the indulgence of savage brutality towards prisoners of war. Operations of nose-making may therefore have been performed at much earlier periods; and, indeed, some such surgical procedures are noticed by Celsus and Galen.

The entire nose, or a portion only, may require to be re-made; in consequence of destruction by disease or injury, or owing to congenital malformation.

(1.) *Nose.*—Restoration of the entire nose may be accomplished by either of two plastic operations. In both the nose is re-made by borrowing a properly devised flap of sound integument, and adapting it to the remnant organ,—itself in a sound state for its reception; but in one operation—that of Tagliacozzi, or the Italian method—the flap was taken from the inside of the arm; in the second, or Indian operation, the flap is taken from the forehead at the root of the nose. The latter operation is now practised, exclusively. It was introduced into this country by Mr. Carpue, in 1814; who also improved the original proceeding by adding a septum nasi, and by the employment of sutures. He was soon followed in Germany by Graefe and by Dieffenbach, and since by other Surgeons. In this country, the operation was more especially brought into practice by Lizars, Liston, Sir W. Fergusson, and Mr. Skey.

The Indian operation.—This operation consists of three distinct procedures performed in succession, at different periods, to complete the result. (1) The dissection of the flap from the forehead, and its attachment to the remnant nose; (2) the detachment of the root of the flap where it is twisted down from the forehead, and the formation of a proper bridge to the nose; (3) the formation of a columna nasi. The *flap* of integument is made thus :—A triangular piece of leather is cut into the shape requisite to form the alæ and apex of the nose, resembling the shape of the former nose; or, in a congenital case, of such fashion as may suit the face. An ample flap should be made, as the new nose shrinks considerably for months after its formation. Each alar portion should be sufficiently free to allow of being turned in to form a complete nostril; an important practical point, due, I believe, to Dr. Lichtenberg. This outline model is laid upon the forehead with its base upwards, and its narrow peduncular part between the eyebrows at the root of the nose; and the outline is marked out on the skin with ink. (Fig. 667.) If the forehead be low, this flap may be somewhat inclined to either side, rather than encroach on the scalp, and perhaps form a hair-growing nose. The cicatrized remnant of the nose is then to be freely but carefully pared. The flap, as marked out on the forehead, must be dissected down; care being taken to make it of uniform thickness, but not to interfere with the periosteum or pericranium; and that the peduncular strip, at the root of the nose, be of sufficient length to allow of its being twisted round without affecting the circulation through it, as the channel through which the supply of blood to the flap alone depends. To facilitate this twist, the incision may be extended a little longer downwards on the side to which the flap is turned. Bleeding having ceased, the flap is brought round and its edges neatly adjusted to the pared margin of the remnant nose, and evenly fixed with sutures; observing—as Dieffenbach directs—to fold the edges of the flap inwards, which will thus give a fulness to the resulting organ. The new nose is to be supported, not stuffed, with a

FIG. 667.



little oiled lint; and wrapped in cotton wool to maintain the circulation. The edges of the wound in the forehead, corresponding to the peduncle, may be united with a suture; the rest of the surface healing by granulation, water-dressing should be applied.

In a few days the nose will have become plump and purplish red; but, this subsiding, union takes place and the organ becomes consolidated.

Then, after about three months, the *twisted strip* of skin may be cut through, and adjusted evenly. To avoid a pucker, it may be necessary to excise a small portion.

The *columna nasi* is best restored by forming it out of the upper lip, as recommended by Mr. Liston, who practised this procedure with great success. First, the inner surface of the apex is pared. Then, a perpendicular strip is cut out of the centre of the upper lip, a quarter of an inch in breadth, and consisting of the whole thickness of the lip. The frænulum having been divided by a touch with the bistoury, this strip of the lip is turned, not twisted up; the labial margin is thinly pared, and the raw surface adapted to that of the apex; the two are retained with a twisted suture, and the edges of the lip-wound brought together by two more such sutures. If troublesome bleeding occur from the coronary artery, one of these sutures should be so placed that the needle shall transfix the ends of the vessel.

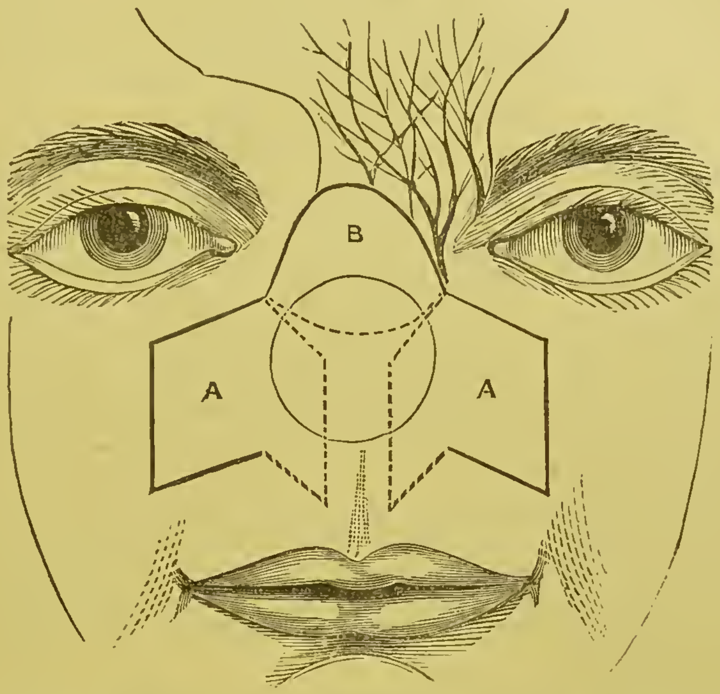
During the process of complete restoration, the nostrils must be dilated occasionally, by introducing silver tubes up these passages. The exposed mucous membrane of the raised strip of lip acquires a cutaneous character, while the interior of the nose resembles a mucous membrane and is moistened with a mucous secretion. Patients, who had previously been snuff-takers, have enjoyed a pinch of snuff, apparently with as much gusto as the oldest and most experienced nose could possibly have imparted. But even should our constructions fail in enabling a patient to resume a nasty habit, a nose is still a nose, "although there's nothing in't."

Certain *exceptional* conditions may be met by different plastic operations.

When the alæ and septum are wanting, but the nasal bones remain, the procedure devised by Mr. Francis Mason may sometimes be adopted with advantage. It consists in forming two small lateral flaps, of square shape, A, from the integuments of the cheeks, and one small upper flap, nearly semicular, B, from over the root of the nose (Fig. 668); these flaps are brought across the nasal gap, as a base of support for the frontal flap. In making the lateral flaps, the margins of the nasal gap are left; and the flaps are taken from sound tissues, about three-quarters of an inch away from the margins of the gap. Having dissected up these portions of integument, from without inwards to their bases of attachment, they are reflected so that the skin-surface is laid towards the nostrils, and united in the middle line by sutures. The aperture remaining above is then closed by the upper flap, reversed with the skin-surface downwards, upon the lateral flaps. The incisions should be so placed, as to avoid, if possible, the angular branch of the facial artery, for the nourishment of the frontal flap. This portion of integument can be brought down at once, or by an after operation.

When the nasal bones are wanting, and the gap is of larger size, Mr. John Wood's operation offers a suitable recompense. It consists in bringing the cheeks closer together, over the aperture, and in making a columna, as a base of support for the frontal flap. Two vertical incisions are made through the upper lip, on either side of the middle line, including a portion about half an inch broad; and this is turned up. The lateral portions of the lip are brought together with hare-lip pins and twisted sutures. The upturned portion of the lip is then split from below upwards, so that the mucous and cutaneous surfaces shall be continuous and looking inwards, the raw surface presenting outwards. Thus the vertical depth of the labial flap is nearly doubled in extent. The cheeks are now to be dissected up from their deep attachments, on either side outwards, for about an inch in extent, or sufficiently to form two lateral flaps; they are brought together across the lower part of the chasm, in such manner that their deep raw surfaces shall be in contact with the raw surface of the upturned labial flap,—the parts being retained in position by wire sutures, and tension taken off the lateral flaps, by stout hare-lip pins, transfixing these parts across the nasal cavity, whereby the margins are lifted up at the lines of junction. By a subsequent operation, the frontal flap is made in the usual manner, from the skin of the forehead, and twisted down; the edges of the aperture having first been pared, and the skin over the lower part of the lateral flaps having been reflected from below upwards, in order to lay bare an extended raw surface on which to implant the forehead flap. The parts are retained *in situ* by wire sutures.

Fig. 668.



(2.) *Columna nasi.*—This portion of the nose may *alone* require restoration, in consequence of its separate destruction by disease involving the septum. The nostrils thus present one large gap, and the nose becoming depressed,—more so with destruction of the bones—great deformity results. The upper lip also, having lost the support of the columna, becomes pendulous, projecting, and thickened; augmenting the disfigurement. Restoration of the columna may be effected by the operation already noticed as supplementary to that for the nose; by means of a tongue taken from the middle of the upper lip. In case of a short upper lip, the columna may be raised from a horizontal flap out of the lip, or from the adjoining part of the cheek.

(3.) *Ala.*—When one ala only is deficient, a flap of integument, suitably shaped, may be raised from the cheek, and adjusted to the part, the edges of which have been previously pared, and retained there by a few points of suture. When both alæ are wanting, or if the cheek be thin, the flap had better be brought from the forehead. The connecting pedicle will necessarily be long and thin; and to maintain the vitality of the engrafted flap, a groove had better be made in the dorsum of the nose to receive the pedicle. Nasal *fistulæ* may admit of repair in like manner; the aperture being closed by a portion of adjoining skin borrowed from the cheek or forehead.

(4.) *Depressed Nose.*—Depression of the *apex*, or of the *bridge* of the nose, may severally occur; owing to the loss of the septal cartilage, or of the septum and nasal bones,—the fabric of the organ, although the external parts remain entire.

These defects may be remedied by loosening the alar connections of the nose, and drawing integument from the cheeks; thus raising the depressed portions of the organ, according to the proceeding of Larrey and Dieffenbach, who revived the operation of Celsus; or by the elevating operation of Sir W. Fergusson,—a simplified modification of that proceeding.

The point of a small scalpel, says Sir W. Fergusson, was introduced under the apex, and the alæ were separated from the parts underneath; the knife was carried on each side between the skin and the bones, as far as the infra-orbital foramen, taking care not to interfere with the nerves; when, by passing the point of my finger below the nose, I caused the latter organ to be as prominent as could be wished. I now passed a couple of long silver needles, which had been prepared for the purpose, with round heads and steel points, across from one cheek to the other, having previously applied on each side a small piece of sole-leather, perforated with holes at a proper distance; then I cut off the steel points, and with tweezers so twisted the end of each needle, as to cause the cheeks to come close to each other, and thereby render the nose prominent. Thus, by bringing the cheeks more into the mesial line, a new foundation, as it were, was given to the organ. Adhesion followed in some places, granulation in others; in the lapse of ten days the needles were withdrawn, and in the course of a few weeks, when cicatrization was complete, the nose presented as favourable an appearance as could reasonably have been desired.

In all these *opérations de convenance*, and of very uncertain result, "let it"—as Mr. Skey advises—"be the patient who urges the operation." The responsibility will then be divided. Sloughing of the new nose took place in one of Mr. Liston's early cases; in another, hæmorrhage occurred under the flap, on the ninth day, and more than a pint of blood was lost; while, two patients out of six died, on whom Dieffenbach operated, owing probably to an unfavourable state of constitution.

Artificial noses have been devised, instead of resorting to operation. Formerly made of metal, flexible noses are now constructed of india-rubber, and having the colour of skin peculiar to the face of the individual. An artificial organ somewhat improves the sense of smell, thus becoming useful as well as ornamental. But the comparative merits of plastic and mechanical skill should always be well considered, with regard to each particular case; without anticipating the failure of operation pictured by Hudibras—respecting the Italian method—

> "That when the time of Noch was out,
> Off dropped the sympathetic snout."

The Frontal Sinuses are subject to certain diseases not peculiar to these osseous cavities, but originating in them as the seat of disease. *Abscess* forms occasionally, within the frontal sinuses, accompanied with great pain, of a dull, heavy, aching character; and subsequently expansion of the cavity, followed possibly by caries, and symptoms of inflammation extending to the membranes of the brain. Warm fomentations and other palliative measures may be employed in the first instance; but evacuation of the matter formed will probably become advisable. This would be done by trephining the anterior wall of the sinus, using a small trephine. *Chronic Abscess* or *Mucocele* may result, when the communication between the frontal sinus and the anterior ethmoidal cells is closed up, and muco-purulent matter accumulates in the sinus. A tumour or swelling is at length presented, between the root of the nose outwards, attended with displacement of the eyeball, and frontal headache. This swelling may be mistaken for a solid tumour or morbid growth within the sinus; but at a later stage, the expanded wall of the sinus becomes thinned or points, when the fluid character of its contents can be felt with the finger; previous to which, an exploratory puncture will show the nature of the swelling. The mucus having been discharged, the opening may be enlarged sufficiently to ascertain the seat of obstruction into the nasal fossa; a communication should be re-established by passing a probe or trocar downwards and backwards through the anterior ethmoidal cells, taking care to maintain the passage for some days, while the frontal sinus is brought into a healthy state by dilute astringent injections. The cavity should be closed as soon as possible, lest a fistulous opening remain, forming, with the nasal passage, an aerial fistula, which would be difficult to heal. *A cyst*—hydatid or fatty—is sometimes produced in the frontal sinus; giving rise to a similar tumour, and requiring similar treatment, by puncture and injection, without the occasion for an opening into the nose. *Exostosis*—the ivory variety—presents a hard, bony tumour, in the situation of the superciliary eminence, or at the inner angle of the orbit; thus resembling enlargement of the frontal sinus, by chronic abscess, or perhaps intra-cystic formation. But the continued hardness, and very slow growth of exostosis, are characteristic of this tumour; unaccompanied also by any previous symptoms of inflammation. The uncertainty of diagnosis will relate to the seat of origin, in regard to any such bony outgrowth; whether it may be attached to the outer plate of the frontal sinus, or that it may have proceeded from the inner or deeper plate, having therefore relation to the brain, and forming an outgrowth within the sinus. In the former case only—that of superficial exostosis—the tumour admits of removal; yet with considerable difficulty, owing to the broad attachment, and extreme density of the bony outgrowth. *Polypus*—whether of mucous, fibrous, or of malignant character—springing from within the sinus and expanding the cavity, may be treated in the same way as an abscess; the trephine being applied with the view of making an aperture for extirpating the tumour.

Fractures of the frontal sinus are liable to occur from direct violence, as a blow between the eyes; driving in the anterior wall alone, and perhaps producing a compound fracture, with the lodgment of some foreign body, as by gunshot wound; or fracturing also the posterior wall. In either case, the importance of the injury will depend on the presence of cerebral symptoms. Certain appearances might mislead the diagnosis; the removal of a portion of the anterior wall of the sinus, leaving the mucous membrane entire, may be attended with an expansive movement of that membrane during each expiration, which somewhat resembles the pulsations of the dura mater; and, when the frontal cavity is opened, the discharge of muco-purulent matter, mixed with blood, may resemble softened cerebral substance, as if the posterior wall were fractured. Gentle examination with the finger will at once determine the nature of the injury. These fractures must be treated with reference to contusion; or the extraction of any foreign body, or fragments of bone from the sinus, and closure of the wound; and also with regard to cerebral compression, or the supervention of inflammatory symptoms. *Foreign bodies* are sometimes lodged in the frontal sinus; as a bullet, from gunshot wound. It may remain quiescent, occasioning but little inconvenience; and at length be discharged through the nose. *Worms* have also been discharged from the nostrils, developed apparently in the frontal sinuses; their supposed origin being the introduction of ova from flowers or stagnant water. Various indefinite symptoms may suggest the possible development of worms; supciliary pain or tingling sensation of some duration, with perhaps faintness or giddiness, and disturbance of vision. Dryness of the nostril, or an abundant secretion, sneezing, and itching of the nose, may look like a catarrhal attack; but all these symptoms recur at intervals, as if provoked by the movements of the worms within the sinus. To destroy and dislodge these intruders, various saline injections may be tried by means of the nasal syphon-douche; aided perhaps by plugging the posterior aperture of the nares on the same side, in order thus to direct the current more forcibly into the sinus through the anterior ethmoidal cells. Common snuff, taken with a forcible inspiration, has had the effect of killing the enemy,—a good apology for an otherwise nasty habit.

CHAPTER XLVI.

INJURIES AND DISEASES OF THE MOUTH.

THE LIPS.—*Wounds* of the lips differ in no way from these lesions in general, excepting the liability of excessive hæmorrhage, compared with the extent of injury, when the coronary artery is divided. The vessel will have to be secured by means of a twisted suture, as for hare-lip; and care must be taken that the needle which brings the surfaces together, shall transfix the lip on either side, so as to command the cut ends of the artery beneath the mucous membrane. It is the arrest of hæmorrhage by acupressure. Otherwise, the blood collecting within the mouth may be swallowed, and thus large quantities of blood have been lost imperceptibly to the Surgeon. It should be observed that the cut surfaces are placed in even apposition, as shown by the margin of the lip. The bead head of the pin having been thrust up to the lip, the pointed end is clipped off with cutting-pliers. Collodion is sometimes brushed over the part thus adjusted by suture, but I think without any advantage. In two or three days the pin may be withdrawn, leaving the twisted thread, encrusted with blood, as a support, until it drops off.

Hare-lip.—This deformity is a congenital fissure of the upper lip, from arrest of development. It is usually situated a little to the left side of the middle line of the lip below the nostril; sometimes on the right side; in either case forming *single* hare-lip. (Fig. 669.) Two such fissures may be present, one on either side, the central and intervening portion of the lip projecting as a short rounded process; forming *double* hare-lip. (Fig. 670.) One fissure is usually deeper than the other, passing even into the nostril. In connection with this latter deformity of the lip, the median portions of the superior maxillary bones,—each containing the two incisor teeth, and which constitute a distinct bone in the human embryo and in the lower vertebrata—the inter-maxillary or pre-maxillary bone,—may be disconnected on one or both sides and project forwards, or depend from the septum narium, as a snout. (Fig. 671.) The hare-lip fissure is opposite the junction of the inter-maxillary bone with the superior maxilla, between the outer incisor and the canine tooth. At this lateral line of junction, there is often a deep notch in the alveolar arch, associated with the lip-fissure, in the case either of single or of double hare-lip. (Figs. 672, 673.) Fissure of the bony or hard palate or of the soft palate—cleft palate—not unfrequently coexists with hare-lip; and the median gap in the alveolar arch may extend

Fig. 669.*

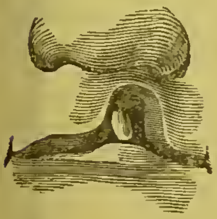


Fig. 670.*

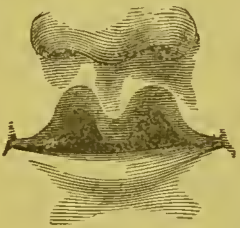


Fig. 671.*

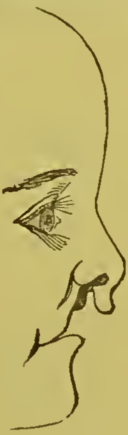


Fig. 672.*

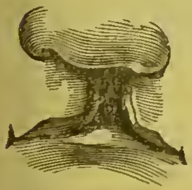
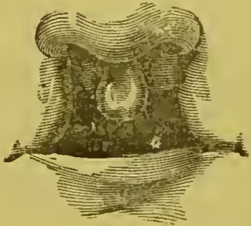


Fig. 673 *



* After Mason.

backwards into a fissure of the palate. Cleft palate, however, frequently exists without hare-lip.

No particular functional inconvenience attends this deformity, but extensive hare-lip interferes with the infant's power of sucking.

Treatment.—The *age* for operation—to remedy this congenital defect—has been the subject of much difference of opinion among some of the best Surgeons. There have been successful results at all ages; from a few hours after birth, a few days, weeks, or months; or at a later period, not until after the commencement of dentition. Having regard to the strength of the child, and that no unfavourable condition ensues from some delay, a month or six weeks will probably be about the proper time for operation.

Operation.—The child having been swathed in a large towel or piece of sheeting, thus completely securing the hands and feet, it is laid in the nurse's lap, so that the head of the infant shall be fixed between the Surgeon's knees. Chloroform may of course be administered, but even then the position of the child, as described, will much facilitate the operative proceedings. Taking the lower corner of one side of the fissure between the thumb and finger and pulling forward the lip on the stretch, the Surgeon just divides the frænum with a straight and narrow bistoury, so as to free the lip; entering the point of the knife at the apex of the fissure, and carrying it forwards to the margin of the lip, the edge of the fissure is pared on that side, and then on the other side, held in like manner; care being taken that the whole thickness of the lip is pared. (Fig. 674.) The pared edges are brought together and evenly adjusted, and secured by one or two twisted sutures. (Fig. 675.) The hare-lip pin should be entered from one-third to half of an inch from the cut edges, and passed deeply, to about two-thirds, through the substance of the lip, on either side of the fissure. A strong silk thread is twisted round the projecting ends of the pin, over the lip, in the form of a figure of eight. The point of the pin is snipped off with small cutting-pliers, the head of the pin remaining on the other side. A second suture is applied in like manner. It is most important to observe that the line of continuity of the labial margin be maintained, and that there be no angular puckering at the apex of the fissure. No dressing is required.

FIG. 674.

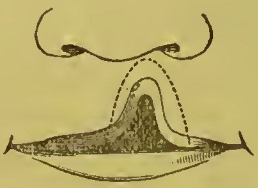
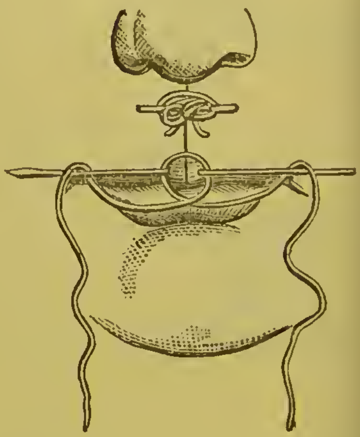


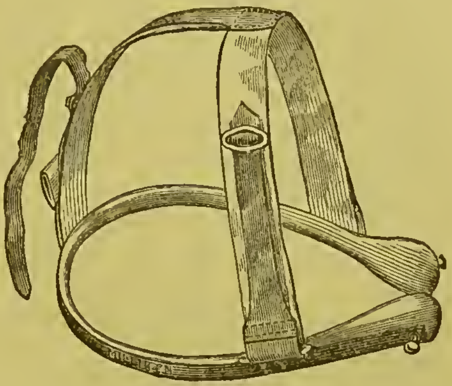
FIG. 675.



Certain little modifications of this operation are urged by some Surgeons of experience. Mr. Skey recommends a slight excurvation of the incision in paring the edges of the fissure, to preserve the form of the lip, which is otherwise liable to be affected by retraction of the cicatrix. When inequality of the fissure exists, Mr. Lloyd was in the habit of preserving a small slip of the flap of the long half of the lip, and of attaching it to the under surface of the shorter half, that there might be no notch or fissure remaining after cicatrization. Mr. Holmes Coote prefers two fine silver sutures, one at the angle of the fissure and the other at the red of the lip, instead of a second hare-lip pin; the former, it is alleged, holding these parts more immovably in contact.

The time for withdrawing the pins is, usually, about the fourth day; or the labial one may be left for a day or two longer. The pin must be gently withdrawn, and the twisted thread caked with the oozed blood should still be left undisturbed on the lip, to which it adheres as a plaster. If this precaution be taken for some days longer, there will scarcely be any necessity that the recently united wound should be supported by "adhesive strapping," or for the use of the spring cheek-compressor devised by Mr. Hainsby. (Fig. 676.)

Fig. 676.



Simple sutures — without the steadying support of pins—are in favour with some Surgeons. Mr. Erichsen has treated hare-lip, double and single, in this way for many years, and most successfully. He, however, restricts the eligibility of this modification of the treatment to cases unconnected with very wide fissure in the palate or great inter-maxillary projection. Under these circumstances the pins are preferable.

Double hare-lip, without malformation of the upper jaw, is treated on a similar principle. If the central lobe between the fissures be of full breadth and length down to the prolabium, the margins of both fissures should be pared independently, and united separately; but if the central portion be short and rounded, it should be sliced to a point downwards and the pared margins of the lip united, embracing this little V-shaped piece above and coming into contact with each other below. In both cases, the same needles are sufficient to retain the two fissures, by transfixing the central lobe; the threads are wound round as before. Both fissures may be pared and treated thus simultaneously; or at separate periods, in order, it is said, not unnecessarily to increase the chances of failure.

The median—inter-maxillary—portion of bone, containing the incisor teeth, which not unfrequently complicates double hare-lip, must be dealt with when it projects so as to prevent union of the wound. The projecting portion may be removed with small cutting-pliers; or it can generally be made to recede by gentle pressure, in the course of a few weeks,—this plan of treatment having the obvious advantage of preserving the incisor teeth. It was strongly advocated by Sir A. Cooper. Pressure can be applied effectually by means of a spring-truss, worn several hours daily, until the portion of bone is sufficiently depressed to allow the lip to be brought over it into easy apposition, prior to operation.

M. Genzoul seizes the projecting portion of bone with strong forceps, partially breaks and forces it into the perpendicular; and this immediate mode of replacement has proved successful. If the piece be connected to a perfect septum nasi, it will probably be necessary to remove a triangular bit, base downwards, out of the latter—as Blandin suggested—before attempting to press back the projection. But the excision of the inter-maxillary mass will be desirable—as Sir W. Fergusson recommends—whenever its projection offers the least obstruction to the easy apposition of the lip-fissure. The reasons for removing this bony prominence are—that the incisor teeth will probably become imperfectly developed, and ill-placed backwards, being of no value for use or appearance; and that, while compression may fail in double inter-maxillary projection, one such portion of bone will be even more resistant, for its attachment, on one side, is firmer. If there be a coexisting cleft in the hard palate, it will probably become narrower when the inter-maxillary portion of bone is removed; and thus an artificial palate can be applied with greater advantage, in after years.

The results of operation for hare-lip have been generally successful. Thus, in the hands of Professor Pirrie, of 266 cases, the operation proved perfectly successful in 264; perhaps the largest experience of any Surgeon, but which I can support by a more limited number of excellent results, except an occasional indentation on the labial border.

DISEASES.—*Hypertrophy* of one or both lips sometimes accompanies the irritation of a crack or fissure, or it remains after the fissure has healed, and the source of irritation apparently has ceased. In the one condition, the fissure should be treated on ordinary principles, that the hypertrophied enlargement may subside; or, this remaining, an elliptical portion of the mucous membrane of the lip may be excised, and the wound united by sutures.

Ulceration of a simple character, though perhaps chronic, is liable to occur on any part of the labial mucous membrane; either as a result of the irritation of a sharp portion of tooth, or of a false tooth, or in connection with a disordered state of the stomach and bowels. The treatment having reference to these causes will be, to remove any source of irritation, oral or gastro-intestinal, and to touch the ulcer with nitrate of silver.

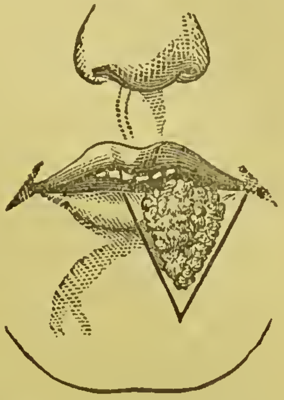
TUMOURS.—The *lower* lip is more commonly the seat of various forms of tumour.

Encysted tumour, small and semi-transparent, and containing a glairy fluid, resembles ranula in appearance, but that swelling is situated under the tongue. Excision of the cyst, by careful dissection, is the most certain cure; or snipping the cyst, and freely cauterizing its interior with nitrate of silver, may not be followed by a return of the tumour.

Erectile tumour of the lip admits of removal by excision, ligature, or strong cauterization. The size and situation of the growth will determine the choice of these modes of treatment.

Epithelial Cancer affects the lower lip, very rarely the upper lip. Commencing as a small warty growth on the lip, or as an indolent tubercle, or as an excoriation of the mucous membrane, surrounded by an inflamed and thickened base, the disease is primarily situated in, or just beneath, the skin or mucous membrane, at or near the junction of the two in the red margin of the lip. Spreading thence, the wart grows in breadth and thickness, the tubercle peels and ulcerates, or the excoriation deepens. Eventually, the ordinary characters of epithelial cancer are presented. (Fig. 677.) The submaxillary glands become involved, and thence enlarged and indurated. The ravages of the disease, as in other parts, may here also be extensive; ulceration destroying the lip, and the lower jawbone and teeth becoming carious. Pain and discharge sometimes wear down the patient.

FIG. 677.



The diagnosis from *chancre* of the lip is mainly determined by the latter presenting a superficial ulcer, raised on a base of cartilaginous hardness; the sore may cicatrize, and the indurated base remain. The submaxillary glands enlarge at an early period, six or eight weeks after the sore commenced. Secondary symptoms appear sooner or later, unless early treatment has been adopted. The upper or lower lip may be equally often the seat of chancre. Cancer of the lip occurs almost exclusively in men, and after the middle period of life; in these two particulars also it probably differs from chancre.

The local and exciting cause of cancer would seem to be some source of irritation; commonly the adhesive contact of a clay-pipe when not coated with sealing wax, or a sharp broken tooth.

Treatment.—Excision, free and early, is the only cure. Some affection of the submaxillary glands does not forbid this procedure; but they also should be extirpated. The incisions in the lip must be directed according to the line of disease. A V-shaped incision will best include the diseased portion when it extends downwards in the lip (see Fig. 677); a quadrilateral operation in other cases; or a more superficial semicircular sweep, when the disease extends along the lip. The lines of incision should be brought together with twisted sutures, as in the operation for hare-lip; a horizontal incision may be closed by simple sutures, uniting the opposed edges of skin and mucous membrane.

This operation sometimes proves permanently successful; but often the disease returns in from six months to two years. Excision should, however, be repeated, to prolong life.

Very rarely, other forms of cancer affect the lip, and more often, the upper lip.

LABIOPLASTIC OPERATIONS.—Restoration of either the Upper or the Lower Lip may be effected by plastic operations, varying in their design according to the deficiency of structure.

The *Lower Lip*, partially destroyed by disease or injury, admits of restoration from the cheeks, which readily supply both skin and mucous membrane.

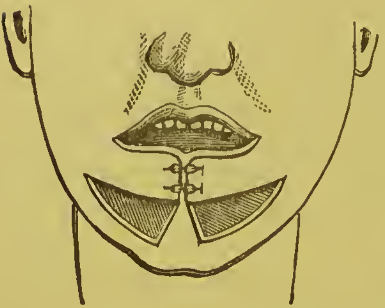
The *Celsian* operation, as described by Malgaigne and put into practice by the late M. Bonnet, of Lyons, is simply this:—The affected part of the lip, as in the case of cancer, having been removed by a V-shaped incision, or by two vertical incisions down to the base of the jaw, united by a transverse incision, the cheiloplastic operation of restoration will vary accordingly, with reference to each such deficiency.

When a *triangular* portion of the lip and chin has been removed, this defect may be repaired by a transverse incision from the angle of the mouth, on each side, into the cheek, thus loosening the lower lip. The margins of the V-shaped incision are then united by suture; while any portion of the upper border which may not be required for the formation of the new lip, from out of the cheek, is united to the part with which it is in contact. The mucous membrane in the mouth should be united to the skin by fine sutures. When the loss of substance is *quadrilateral*, two other incisions, parallel to the two prolonging the angles of the mouth, must be made along the base of the jaw. The two quadrilateral flaps, thus marked out, are then dissected from the bone, and brought forward, union in the middle line being obtained by sutures, as in the former operation.

Mr. Syme's operation consists in removing the cancerous ulcer by a large V or triangular incision, extending from the angles of the mouth to the chin. The apex is then the starting-point of an incision on each side, obliquely downwards and outwards, *under* the body of the jaw, and terminating in a slight curve outwards and upwards. The flaps, thus indicated, are dissected outwards, and raised upwards, until the original triangular incision lies in a horizontal line, forming the margin of the new lip; the incisions under the jaw are then brought together into a vertical line, and are retained by hare-lip pins with twisted sutures.

Dr. Buchanan, of Glasgow, in 1841, had devised a similar operation:—The diseased portion of lip having been removed by an *elliptical* incision, extending from angle to angle of the mouth, an incision is then carried downwards and outwards to the chin, on each side; and from these points an incision is made upwards and outwards, on each side, on the body of the jaw, parallel to and corresponding in length to the elliptical incision below the lip. (Fig. 678.) The flaps, having been dissected, are raised to a horizontal line, and these are united in position along the middle line.

Fig. 678.



This operative procedure may surpass Syme's, when the incisions are required to meet the removal of a large, elliptical-shaped portion of substance, comprising the whole lip from side to side; but it will, otherwise, be desirable to have the incisions as little on the face as possible. All these plans of labioplastic operation for the lower lip are, however, superior to that of Chopart's operation, whereby the flaps of integument were raised from below the jaw, even as low down as to the hyoid bone.

(2.) The *Upper* lip less frequently requires restoration, its structure being comparatively seldom the seat of cancer-growth.

Shrinking of the upper lip sometimes ensues from profuse salivation, by which this part is tightly stretched over the alveolar arch, and perhaps adherent to the gums.

Von Ammon rectifies this condition by the following plastic operation:—The lip is first detached from the gum, then an incision is carried upwards from the angle of the mouth, for about an inch and a half, towards the ala nasi. The tense parts separate, and this longitudinal fissure assumes a triangular shape. A flap of integument is dissected from the cheek, and brought down to occupy the space at the angle of the mouth. Precisely the same operation is performed on the opposite side.

The *central* part of the lip may be destroyed, and the two adjoining portions become drawn up towards the septum and alæ nasi, exposing the incisor teeth.

Dieffenbach rectified this deformity by bringing a sufficient amount of integument from the adjacent substance of the cheeks, on each side. An incision by the side of the alæ nasi is carried round to the middle line of the lip, and down through its margin; each half is loosened, and brought together with twisted sutures.

THE CHEEKS.—*Wounds* of the cheeks offer nothing worthy of special notice, in respect to the nature of these lesions. They must be neatly united, by means of simple sutures or hare-lip pins and twisted suture.

Salivary Fistula is a perforation or division of the Stenonian duct of the parotid gland, whereby the saliva dribbles out on the cheek. This condition may result from wound of the cheek, sometimes in removing a tumour situated over the duct; or in consequence of abscess or ulcer of the cheek, implicating the duct. The fistulous aperture and trickling saliva are a source of great disfigurement and inconvenience.

Treatment.—The object is to restore the continuity of the duct, as the natural channel for conveying the saliva into the mouth, where it opens upon the inner surface of the cheek, by a small orifice, admitting only a very fine probe, opposite the crown of the second molar tooth of the upper jaw.

Recent salivary fistula can sometimes be closed by pressure alone, by means of a compress applied over the fistulous aperture in the cheek; the saliva resuming its natural course through the duct, which still remains open. I have thus cured a fistula of this kind, in two instances. In a more established condition, the edges of the external aperture should be pared and brought together, and then pressure applied. *Confirmed* salivary fistula is probably attended with closure of the natural opening into the mouth. It will be necessary to form an artificial communication with the duct; and this may be done, either by passing a small seton from the inside of the cheek into the fistula, as Desault recommended; or by introducing a wire, red-hot, or heated by galvanism, as Mr. Marshall has suggested. The external fistulous opening must then be pared and closed with a twisted suture.

Congenital Transverse Fissures of the Cheeks, extending from the angle of the mouth to the anterior border of the masseter muscle, or up towards the malar bone. Such fissures are rare. They must be treated on the same principle as hare-lip; their edges being pared and brought together by pins and twisted sutures, that union by adhesion may close the fissure.

Congenital Contraction of the Orifice of the Mouth, or even complete closure at birth, may be found, as in the nostrils. This condition will tax the ingenuity of the Surgeon to overcome by dilatation, or suitable incisions. The cut edges of skin and mucous membrane should be united by suture.

DISEASES.—*Corroding Ulcers* of the cheek may occur in two forms. *Lupoid* ulcer has all the characters of this form of Ulcer; the hollow excavation, absence of granulations, thin, worm-eaten, and everted margin —thus contrasting with a cancerous ulcer. The ravages of lupoid ulceration are equally notable. The features disappear as the ulcer extends; the nose and mouth may fall into one cavity and the eye drop down from the orbit, exposing the back of the pharynx, nares, antrum, and interior of the orbit, in one large, irregular, and carious-bottomed excavation; which completely disguises any recognition of the individual face, or even obliterates its form as that of the human visage. Such a result had taken place in a poor woman, who, if I remember rightly, was found on a door-step one night, many years since; and a wax-model of whose horribly remnant face is deposited in the Museum of the University College, London.

The *treatment* of this form of Ulcer is noticed under Lupus. Chloride of zinc in paste, well applied to the excavation, is far more effectually curative than excision. This I once saw in a case treated by Mr. Liston, and similar results were obtained by Mr. Moore, in two cases. In one of these, the surface was known to have remained perfectly healthy two years and a half afterwards; although the disease had destroyed the greater part of the contents of the right orbit, the eyelids and skin in the neighbourhood.

Cancrum oris.—Another form of corroding ulcer, a phagedæno-gangrenous ulceration affecting the inner surface of the cheek and lip. Commencing, usually, with a brawny, tense, shining swelling of the cheek, the corresponding interior of the cheek soon presents a deeply excavated, round ulcer, having a brown, pulpy, sloughy surface. Differing somewhat from this typical condition of the disease, it may commence, in its most rapid form, as a black gangrenous spot, unaccompanied by any surrounding inflammatory swelling; or, in a milder form than usual, it presents a shallow, ash-coloured ulcer, situated on the inside of the lip, more often the lower one, and extending to the cheek. This latter form of the ulceration seems to have a diphtheritic character.

The disease may extend considerably; the excavated ulcer inside the cheek perforating and opening in the form of a circular, dark-coloured, gangrenous cavity, communicating with the mouth. The gums are turgid and spongy; while a fœtid saliva and putrescent discharge dribbles from the lips. Comparatively little pain attends the process of destruction; but the constitutional exhaustion is often fatal, and the patient sinks in a comatose state.

The *cause* of cancrum oris is general debility; resulting from poor living, among the ill-fed and otherwise destitute children of large towns, who are chiefly affected. Or the disease may be a consequence of one of the eruptive fevers, as measles or scarlatina, or any other severely reducing illness; and, occasionally, it has followed the prolonged administration of mercury. The feeble, wan, abject aspect of the poor little victim will be readily associated with the characteristic appearance of the buccal or labial ulceration.

Treatment.—Local applications must be employed to arrest the disease, and correct the fœtid, self-poisoning discharge. Hence, the nitrate of silver should be freely applied, or the strong nitric acid will probably be necessary; and the mouth should be syringed with chlorinated solutions. But the constitutional treatment is most curative; and quinine and ammonia, the latter not pushed to its depressing effect, with wine, beef-tea, and other nutritious food, are the most efficient measures. Chlorate of potash, in large doses, is said to have an almost specially remedial influence. My own experience does not enable me to confirm this view.

The deformity resulting from cicatrization may require some plastic operation for its rectification.

TUMOURS.—Various species of morbid growths form, occasionally, on or in the cheek: fatty and fibrous tumours, as I have seen in three cases; cartilaginous, cystic, and cancèrous; or vascular and erectile tumours.

The removal of any such tumour can generally be accomplished by careful excision, having regard to the thickness of the cheek and the relation of the growth to surrounding parts; or the subcutaneous application of ligature will probably be available, in the case of an erectile tumour, which I have thus removed from the inner side of the cheek. It is sometimes remarkable how much the cicatrix, after such operation, becomes effaced in the course of years.

TONGUE.—*Wounds.*—Severe hæmorrhage, principally from the lingual artery, is the chief point of practical importance, in wounds of the tongue. The lesion itself is apt to occur by an accidental bite of the tongue, and not unfrequently severe laceration is thus occasioned during an epileptic fit. When the organ is protruded, a blow on the lower jaw has been known to nearly sever the tongue; as happened in the case of a patient of mine, to which I have particularly alluded in illustration of the general law of primary adhesion, and a similar extent of lesion has been caused by a blow in a prize-fight. Punctured wounds are liable to happen; as from a blow received on a pipe in the mouth, a thrust from a fork, or from the habit of holding pins between the lips, or accidentally taking a needle into the mouth with food. Insect-stings of the tongue sometimes occur, as from a bee or wasp getting into the mouth during sleep, or in eating fruit.

Treatment must first be directed to the arrest of hæmorrhage, which may be effected by ligature or torsion of the lingual artery; any oozing of blood being then restrained by means of ice-water held in the mouth and repeatedly renewed. The divided parts should be adjusted with sutures; which, however, speedily separate, and union will probably as speedily take place. It is a remarkable fact, how much the sense of taste is gradually restored; showing that the gustatory nerve, when divided, reunites without apparently any interruption in the continuity of its nerve tissue. The irritation and swelling arising from an insect-sting may be allayed by rinsing the mouth often with a dilute solution of acetate of ammonia.

Foreign Bodies are sometimes thrust into the substance of the tongue, and may even become imbedded and concealed. In the Museum of Guy's Hospital, there is a specimen (1674) showing a piece of tobacco-pipe, over which the substance of the tongue had closed. Frequent hæmorrhage occurred, and ultimately proved fatal. The crown of the second molar tooth was driven into the tongue by a musket-ball, and there remained quiescent for a period of thirty-two years; when an abscess formed and discharged it.

In any case, the foreign body should of course be removed, if possible.

Congenital Defects.—*Tongue-tie* signifies a congenital shortening of the frænum linguæ, whereby the apex of the tongue is depressed and restrained; so that it cannot be protruded beyond the incisor teeth, and there is difficulty in sucking, and eventually indistinct articulation in the adult.

This defect can easily be remedied, by snipping the bridle across with blunt-pointed scissors; observing to direct their points downwards just to avoid the ranine arteries. Not unfrequently, mothers request such relief very unnecessarily.

Other congenital defects are very seldom met with, and therefore have less practical importance.

The tongue may be found *adherent* to the floor of the mouth, an instance of which malformation is recorded by M. Sernin; or the union exists in the form of membranous bands, as in three cases mentioned by Maurrain; and in the adult, a similar condition is sometimes the result of sloughing. Any such restraint to the free movements of the organ will interfere with its functions, in sucking, mastication, and speech. But the tongue, when bound down by adhesion, can be dissected up, or the bands divided; care being taken to prevent reunion by passing the finger between the surfaces once or twice daily during cicatrization. Excessive *mobility* of the tongue may be due to congenital looseness of attachment, or acquired by a too free division of the frænum for tongue-tie. In either case, the organ is liable to be turned back and swallowed, causing suffocation. An unnaturally *long* tongue may be an occasional form of actual monstrosity; in a girl, according to Fournier's description, the tongue was so long, that when protruded, with head erect, the tip reached to her chest. *Bifid* tongue is a rare congenital defect; and which admits of reparation, by paring the edges of the cleft, and bringing the parts together with sutures, as for cleft palate. *Absence* of the tongue merits notice; for in a case narrated by M. de Jussiew, the powers of speech and taste were nevertheless enjoyed.

DISEASES.—*Prolapsus* of the tongue may undoubtedly occur; it having been noticed by Zacchias in 1628, Bertholin, Sauvages, Percy, Laurent, Mirault, Maurant, Lassus, Crosse, Liston, Clanny, Hodgson, Teale, and other Surgeons. In a case recorded by Professor Humphry, the organ was enormously enlarged, both in circumference and length; the portion immediately within the lips having five inches circular measurement, and when the tongue was drawn into the mouth as far as possible, the length from the upper lip to its tip measured two inches. The protruded organ had been habitually suspended in a bag from the head. It was soft and supple, but of a granular or warty appearance, with deep clefts, owing to hypertrophy and separation of the papillæ; the colour remaining natural. The opening of the mouth was enlarged, the lower lip everted, and the angles of the mouth depressed; elongating and giving a peculiar expression to the face. The orifices of the sublingual ducts, also enlarged, were situated just in front of the edge of the lip; and thence the saliva dribbled continually from the end of the tongue, to the amount of more than half a pint daily. The mental portion of the jaw and inferior incisor teeth had become everted by constant pressure of the tongue, forming a curvature in which the organ lay; and a wide interval existed between the teeth, which, even when the mouth was closed and the molars were in contact, was nearly two inches in extent between the upper and lower incisors.

This condition of the tongue may be congenital, or acquired as a consequence of profuse salivation. It is attributable to hypertrophy, or possibly to a paralytic state of the retractor muscles of the tongue.

The *treatment* of prolapsus linguæ is unsatisfactory. The protruding portion may be removed by excision, a perilous and even fatal adventure; or by ligature, with the formation of a poisonous slough, for a while, in front of the mouth and nostrils; or by means of the écraseur —a mode of excision and rapid strangulation, thus avoiding the risk of hæmorrhage and slough. In like manner, the galvano-cautery may prove advantageous. Pressure has caused the swelling to partly subside, but it has returned again; yet, in slight hypertrophy, it appears from Mr. Fairlie Clarke's table of cases that successful results have been obtained by regular compression, coupled with the application of astringent lotions, especially of alum, sulphate of copper, or tannin.

Atrophy.—Wasting of the tongue is not a disease of the organ itself, but depends upon paralysis of the hypo-glossal nerves; the atrophy being simply symptomatic. Mr. Clarke thus represents the pathology of this affection:—Excluding hemiplegic paralysis, atrophy of the tongue is referable, either to disease of the medulla oblongata, involving the hypo-glossal nucleus, or to disease or injury of the hypoglossal nerve, in its course between the cerebrum and the muscles of the tongue to which it is distributed. Under the first head, the kind of disease may be softening, hæmorrhage, syphilis, or various other causative conditions; the second class comprises morbid growths and injuries. The symptoms differ according to whether the disease is central or intermediate. In the former case, the paralysis and atrophy may affect both halves of the tongue, or be limited to one side. But whether bilateral or unilateral, the affection is not confined to the hypoglossal nerve; the branches of the fifth and eighth pairs, and the facial or portio dura of the seventh nerve, are usually implicated. Thus, the lips, soft palate, vocal cords, and other parts participate in common with the tongue; as manifested by the labio-glosso-laryngeal paralysis, so named by Duchenne. Thence, the functions of articulation, vocalization, and deglutition are impaired or lost. When the hypoglossal nerve, intermediately, is the seat of lesion, the paralysis and atrophy are unilateral. The result of atrophy is fatty degeneration of the muscular fibres of the tongue,—an irremediable condition.

Glossitis.—Acute inflammation of the tongue is attended with sudden enlargement of the organ, which protrudes from the mouth, presenting a red mammillated appearance, with profuse salivation; while the patient can neither speak nor swallow, or scarcely breathe. It is met with rarely as an idiopathic affection, but sometimes as a consequence of over-salivation from the abuse of mercury, or of scalding or corrosive fluids. *Treatment* is urgent, and the tension resulting from infiltration of serum and from congestion can be at once relieved by a free incision on either side of the raphe, along the dorsal aspect of the tongue, thereby avoiding the ranine arteries. But it should be remembered that the œdema may so far involve only one side of the tongue as to cause the lower surface, which swells more readily, to be turned directly upwards; the incision made above thus passing into the tissues naturally inferior, and which would resume this position as the swelling subsides. Tracheotomy may have to be resorted to for the relief of dyspnœa. Saline purgatives will, however, usually complete the reduction of the swelling, when they can be swallowed, after the immediate relief afforded by incisions. Astringent and cleansing gargles are also useful adjuncts.

Abscess of the tongue—should it take place—may be detected on careful examination of the deep-seated, semi-elastic, and fluctuating swelling. It must be punctured as soon as possible.

Ulceration is liable to occur, in a simple form, as the result of irritation by decayed teeth; or in a specific form, as a manifestation of secondary syphilis. Fissures and milk-white stains or psoriasis on the dorsum of the tongue, coupled with the history of syphilis, will determine the diagnosis. The *treatment* varies, of course, with the cause; the removal of a decayed tooth, and aperient stomachic medicines, may prove sufficient to heal the ulcer; or it must be treated as a secondary form of syphilis, by the topical application of nitrate of silver, with the administration of iodide of potassium and bark.

Mucous tubercle, *gummy tumour* in the substance of the tongue, *psoriasis*, and *ichthyosis*—apparently a raised form of the latter affection—are diseases which mostly have a syphilitic origin, and may be treated in like manner. *Eczema* and *herpes*—vesicular forms of eruption—arise from local irritation or stomach derangement, which yield to appropriate treatment.

Neuralgia of the tongue is an uncommon affection, and usually limited to one side of the organ. But the intense pain is aggravated by any movement, and sometimes extends to neighbouring parts; as the jaw, ear, or temple. It may proceed from local irritation, as a carious tooth; or from gastro-intestinal derangement, or general debility. *Treatment* must be conducted accordingly. But faradization has proved curative; and so has excision of a portion of the lingual nerve. *Spasm* of the tongue is spoken of by Romberg as being sometimes associated with neuralgia of the organ; or as a symptom, perhaps, of hysteria or of meningitis.

TUMOURS.—(1.) *Cancer* of the tongue occurs in, perhaps, three forms. *Scirrhus* commences as a firm, incompressible knob on the edge of the tongue, and situate often opposite the last molar or wisdom tooth. Considerable pain and difficulty are experienced in moving the organ and in deglutition, and pain darts along the Eustachian tube towards the ear. The saliva flowing from the mouth, and fœtid secretion accumulating in the throat and exciting cough, combine with the pain, sleeplessness, and want of nourishment, to reduce the patient. At length a deep excavated ulcer is produced, and hæmorrhages occasionally supervene. The submaxillary glands become involved; presenting first a circumscribed and then a diffused tumour in the neck, covered by reddened and thinned integument; this also ulcerates and discharges a thin fœtid fluid, with occasional hæmorrhage. Emaciation and cachexia ensue, according to the duration of the disease. Death took place in ten months, from arterial hæmorrhage, in the case of the late Bransby Cooper. A deep excavation was found at the root of the tongue and the tissues around, extending to the muscles about the hyoid bone, and the adjoining lymphatic glands were infiltrated with cancer.

Soft cancer, in the shape of an irregular lobulated mass, of reddish-brown colour, with vascular red points, and of a spongy succulent character, was the kind of malignant disease in a case recorded by Mr. Ceely, of Aylesbury. The tumour protruded from the mouth, and a large portion, weighing seventeen drachms and a half, was easily peeled off, exposing a large jagged surface covered with coagula. But the hæmorrhage was moderate, and soon repressed with matico powder. The growth returned within a week, yet the man was still alive thirteen years after the operation.

Epithelial cancer appears almost as often on the tongue as on the lower lip. It presents an opaque white raised patch, consisting of matted epithelial-scales, which becoming detached at length exhibits an ulcer of irregular surface, with hard everted edges produced by epithelial infiltration around the ulcer. (See Fig. 679.) Coexisting with such a patch or ulcer on the dorsum of the tongue, I have seen two or more buttons on the hard and soft palate. Considerable pain may be experienced, but the functional inconvenience will depend on the situation and extent of the part affected. The submaxillary glands sometimes remain unaffected. The disease progresses slowly, in one case existing twelve years, in another sixteen years; a far longer period of duration than in other forms of cancer-growth.

Cancer of the tongue is a primary disease, with rare exceptions. Some predisposition seems to be conferred by age and sex, with regard to epithelial cancer. In thirty cases tabulated for Sir James Paget by Mr. Morrant Baker, the disease occurred more often in middle and advanced life; and a similar relation appears from thirty-nine cases collected by Mr. Fairlie Clark. Extreme ages have been noticed; twelve years only, in a case by Liston; ninety years in one of Paget's cases. The disease is far more common in males than females. Thus, in the former series of cases, nineteen were men, and eleven women; and in the latter series, twenty-eight were men, and eleven women.

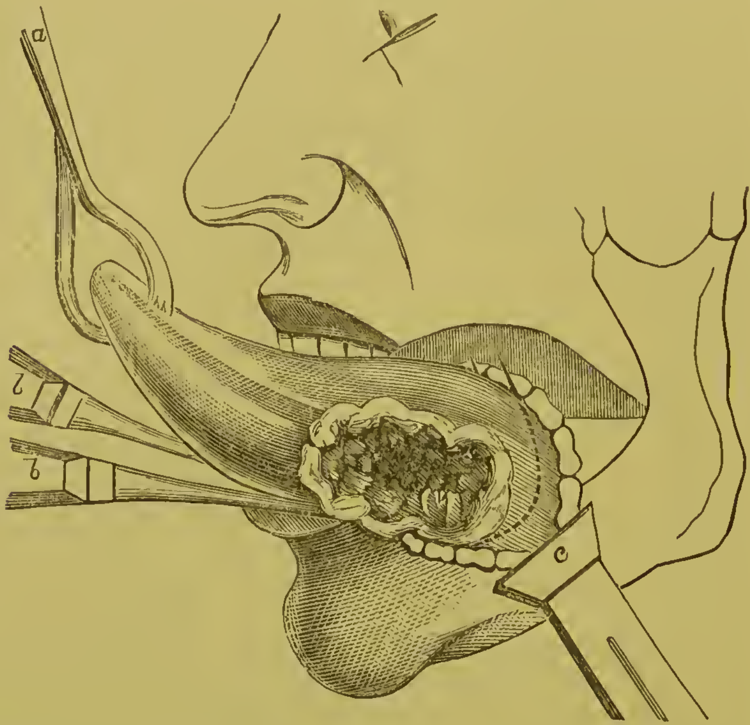
The *duration* of cancer of the tongue is an important factor in its bearing on the question of operation. Of the thirty-nine cases referred to, the average duration was fifty-seven weeks; the shortest period having been fourteen weeks, and the longest beyond six years.

Treatment.—Any cancerous disease of the tongue must be extirpated by surgical operation; no known medicinal treatment having any curative effect. The extirpation should be carried freely around the cancerous infiltration, to lessen the probability of the disease recurring.

Excision may be either partial, or complete removal of the whole tongue. The former procedure is appropriate and practicable when the disease is limited to the tip or anterior portion of the organ; the latter operation becomes absolutely imperative, as the only chance of safety, when the disease is more extensive. These operations of excision may be done with the knife, or by means of the écraseur or the galvanic wire-cautery. The two latter methods of removal are preferable, for the avoidance of hæmorrhage; and the galvanic cautery is more especially advantageous, as being equally effectual, and far more speedy in its operation; but the wire must be applied at a dull red heat, otherwise the bleeding will be no less free than if a knife were used. Strong curved pins are transfixed through the tongue, to guide the écraseur or wire in its course around the part to be removed, or through the base of the organ for complete excision.

Partial excision is easily performed. If the knife be used, chloroform should not be administered, lest with the hæmorrhage, which is often very free, blood should trickle backwards into the larynx and occasion convulsive coughing. The patient being seated in a chair, with the head supported behind by an assistant, another assistant introduces a gag to keep the mouth well open—Wood's gag is here specially serviceable,—the tongue is then drawn forward out of the mouth with a vulsellum, and the cheek retracted. The Surgeon seizing the whole tumour or ulcerated part within the blades of double-hooked forceps or a vulsellum, he passes a curved, blunt-pointed bistoury around it, and by almost one sweep of the knife removes the part. If the lingual artery be wounded, this vessel may be commanded by ligature or torsion, or by a touch or two with the conical-pointed cautery, applied at a dull red, searing heat; any further bleeding can generally be restrained by swabbing with the perchloride of iron, or by ice in the mouth. Rinsing the mouth with a strong solution of the perchloride has seemed to me more effectual than merely applying it to the cut surface, apparently by causing a general contraction of the tongue;

FIG. 679.*



and, subsequently, ice-water, or sucking lumps of ice, seems to have the additional advantage of lessening the inflammatory swelling which soon supervenes. The cut surface rapidly heals, leaving a puckered cicatrix, which is distinguishable from reproduction of the disease by the absence of induration.

Complete excision of the tongue may be accomplished, either by removal through the mouth—the oral operation; or through the cheek, by incision from the angle of the mouth, to reach the tongue—the buccal operation; or by incisions under the jaw—submental operations.

Oral Operation.—This procedure—as suggested by Sir James Paget—consists in first dividing the attachments of the tongue, the genio-hyoglossi muscles connecting it to the jaw in front, and the mucous membrane at the sides, so that the organ can be thoroughly drawn forward. Strong curved pins are passed from under the tongue through its substance, on either side of the frænum, and emerging on the upper surface. Then the loop of the écraseur, or of the galvanic wire-cautery, is cast around the tongue, behind the pins, which prevent the noose slipping and guide it through the substance of the organ and along the floor of the mouth. The wire-cautery will traverse this route in a few minutes; but if the écraseur be used, the instrument should be worked slowly, two minutes being allowed between each movement of the handle, and thus the severation is prolonged to a period of from half an hour to an hour or longer.

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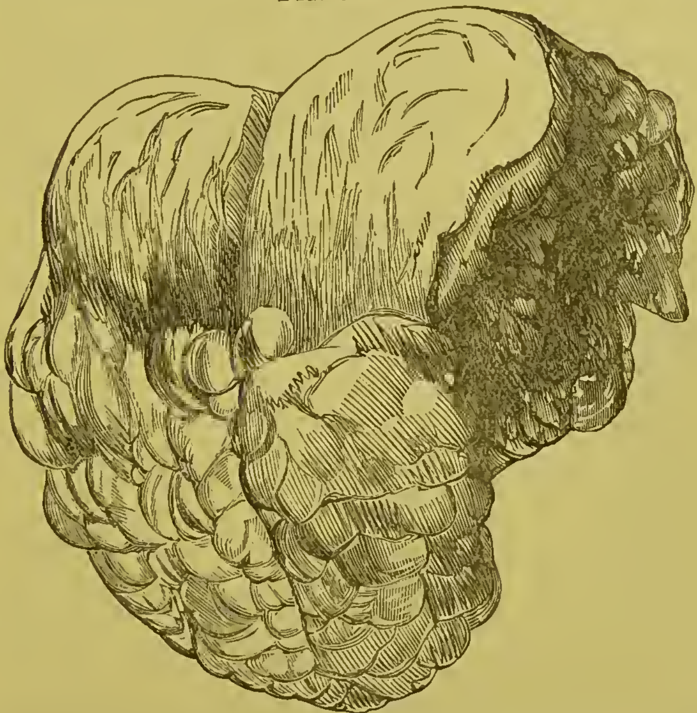
* Royal Free Hosp. (Author.)

Buccal Operation.—By an incision extending from the angle of the mouth to the inner concave angle of the jaw, the base of the tongue is easily reached; then, the tongue having been well drawn forward with a vulsellum, the base is transfixed by two stout curved pins, one on either side of the frænum and projecting above in front of the epiglottis; the écraseur (Fig. 679), or loop of wire, is readily cast around the base behind the pins; and thus the whole tongue is excised. (Fig. 680.) The only bleeding in this operation is from the incision through the cheek, the facial artery requiring ligature or torsion. This incision is finally closed with hare-lip pins and twisted sutures; observing to adapt the line of junction evenly, so that primary union may take place in a few days, and without disfigurement, beyond a slight linear scar across the cheek. In a male patient, the growth of whisker will perhaps hide even that. This buccal operation is connected with the name of Mr. Furneaux Jordan; but I performed the same operation before I had heard of his practice; and in transfixing the tongue I used two curved, sharp-pointed aneurism needles, which I found very efficient and convenient for the purpose of fixing the écraseur-loop, and guiding

FIG. 680.*



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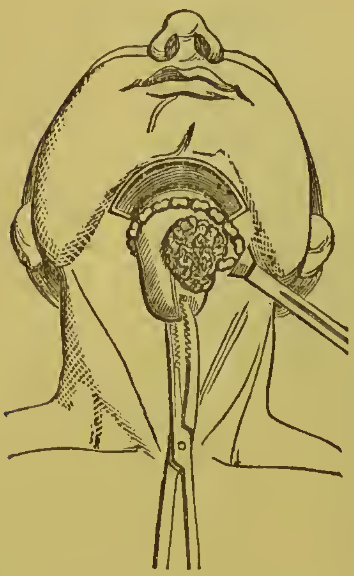
* Royal Free Hosp. (Author.) Same case.

it through the root of the tongue. The operation was devised for the complete extirpation of the tongue, after I had twice removed portions with the knife ineffectually—the disease, epithelial cancer, having returned—but as the sublingual glands remained unaffected, I thought it a fair case for resorting to complete excision, with the view of giving comfort to the patient, and prolonging life, although he was then sixty-five years old. Two years afterwards, when I saw him, he enjoyed excellent health, could swallow any kind of food, and articulate with sufficient distinctness of utterance to follow his former occupation—that of a cab-driver.

Submental Operations.—Three methods have been practised for removing the tongue by procedures beneath the jaw.

The puncture and écraseur operation, devised by Mr. Nunneley, is readily performed. The tongue having been transfixed by a couple of strong curved needles, passed from the floor of the mouth and projecting on the upper surface of the tongue, which had been drawn forward with a vulsellum, as in the preceding operations, a stout-bladed needle, attached by ligature to the noose of an écraseur, is thrust through the floor of the mouth from under the chin, the needle being made to penetrate in the middle line, and about midway between the os hyoides and the chin, so that the point emerges in the mouth by the side of the frænum of the tongue; the loop of the écraseur is drawn up and the needle detached; then the tongue is drawn forward through the noose (Fig. 681, showing also operation by submental incision), which must be planted behind the pins as usual (omitted in figure), and the organ is excised by slowly working the instrument. On withdrawing the noose through the submental puncture, the narrow track of the wound has a somewhat lacerated surface, but this is of little consequence in the process of healing. The operation has proved very effectual as a method of complete excision; and it is far more conservative than either of the remaining submental operations, both of which will probably fall into disuse.

Fig. 681.



Large portions of the tongue have been successfully extirpated by Regnoli's operation;—simply an incision into the floor of the mouth, extending, under the jaw, from one angle of the bone to the other; a vertical incision in the middle of this, from the hyoid bone forwards, will enable the tongue to be more readily drawn downwards through the opening, and nearly the whole organ can then be removed.

Syme's operation, similar to that by Sédillot, for complete extirpation, consists in making an incision through the middle of the lower lip and carrying it over the chin down to the hyoid bone; the symphysis of the jaw is sawn through, and the mylo-hyoid, genio-hyoid, and genio-hyoglossi muscles separated; the two halves of the bone are drawn asunder, and the larynx is drawn forwards, thus exposing the whole tongue down to its very root,—the hyoid attachments. The organ is then to be completely excised. Mr. Fiddes, of Jamaica, subsequently performed this operation, and recommends that the lingual artery should be ligatured and divided on either side, separately, in order to reduce the amount of hæmorrhage.

Ligature.—Portions of the tongue have been removed by ligature, in preference to excision. The risk of hæmorrhage is thus diminished or avoided; but the operation is more painful, tedious, and prejudicial, in consequence of contamination during the course of sloughing. To obviate the first objection, and check the profuse secretion of saliva, Mr. Hilton has proposed and practised section of the lingual nerve, prior to the application of ligature. No sensation from the tumour can then be conveyed along the nerve; no reflected irritation can reach the collateral branches of the fifth nerve; no stimulus to an increased secretion of saliva can be given to the salivary glands. Eminently, therefore, an operation based on a physiological principle, the patient should speak more freely, and swallow with less difficulty; should be relieved of pain in the tongue and jaw, temple and crown of the head, and of the incessant inconvenience arising from the dribbling of saliva; he should sleep better, and become better nourished than before. Mr. Hilton sought for the nerve in the floor of the mouth, and exposed it by an incision along the mucous membrane close to the sublingual gland. Mr. Moore, who has more recently divided the nerve, takes the last molar tooth as his guide, where the nerve coming forward from under the internal pterygoid muscle is covered only by the mucous membrane. Passing a curved bistoury into the mouth and behind the last molar tooth, an incision three-quarters of an inch long down the jaw, and across the course of the nerve, must divide it. Ligature of the corresponding lingual artery has been combined with this operation by Mr. Moore, in order to cut off the supply of blood to the affected part.

Ligature of the affected part may be performed as for nævus; care being taken to plant the operation sufficiently wide of the disease, and to strangle the mass effectually and completely.

A diseased part of the tongue, situated far back in the organ, has been reached by a vertical incision under the jaw, between the genio-hyoid muscles; and in this way Cloquet and Arnott have succeeded in passing ligatures, by means of long needles, through the tongue, and strangling the mass.

The *results* of operation, in the prolongation of life, compared with the mortality in the natural duration of the disease, are decidedly favourable to surgical interference. Thus, in Mr. Fairlie Clark's collection of thirty-nine cases, twenty-five were not submitted to operation, and of these the average period of life was forty-two weeks, and the longest period under two years; but, of the remaining fourteen cases, subject to operation, the average duration of life was eighty-six weeks, and the most prolonged lease six years!

(2.) *Erectile Tumour* or *Nævus* of the tongue is an uncommon kind of growth, and does not attain to a great size. Removal can be effected by excision, or, preferably, by ligature; and it may be necessary to reach the affected portion of the tongue through an incision in the mylo-hyoid region.

(3.) *Fatty tumour* has been known to occur, either in the substance of the tongue or underneath the organ. In the Museum of the Royal College of Surgeons there is a specimen, No. 190, of fatty tumour taken from the one situation; and Sir James Paget removed another oval and bilobed tumour, also from the substance of the tongue, near the apex, where it had been growing for three years. In the Museum of the Middlesex Hospital there is a fatty tumour, one and a half inches long, which was removed from beneath the tongue, where it looked like a ranula; and a lobulated tumour was removed from the same situation by Mr. Liston.

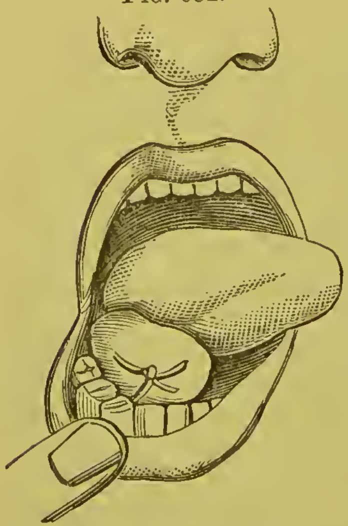
(4.) Growths of other kinds may be mentioned as of even more rare occurrence. The *fibro-cellular* and *fibrous* tumours have, each, been removed from the tongue by Sir James Paget. *Enchondroma* was found in a case recorded by Professor Gross. *Keloid* growth occurred in another case which Mr. Sedgwick narrates, the disease being associated with indurated, raised patches of the same kind on the face, chest, and other parts, in the person of a girl four years and a half old. Tumours, more or less embedded in the substance of the tongue, having a well-defined boundary, may thus be distinguished from swellings arising from syphilitic or scrofulous deposits. *Polypi*, and *warts*, of a pedunculated form, and presenting the usual appearances of these outgrowths respectively, are also occasional productions.

These various species of growths admit of removal by excision, or the polypoid may be strangled by ligature.

(5.) *Ranula* is a semi-transparent, bluish-white, fluctuating, cyst-like, swelling; situated under the tongue, to one side of the frænum, corresponding to the position of the submaxillary gland. The swelling is attributed to a dilatation of the duct—Whartonian duct—of this gland, which presents a cystiform enlargement. (Fig. 682.) In one case, under the care of Sir W. Lawrence, the little finger could be inserted for a short distance into a cylindrical tube, pursuing the normal course towards the gland; and in another instance Mr. Holmes Coote removed a phosphatic concretion, about the size of a pea, from Wharton's duct. The incipient swelling disappeared in a few days, thus indicating the probable mode of origin of ordinary ranula.

Cysts may form, in the same situation, from, perhaps, four sources—(1) dilatation of Wharton's duct; (2) dilatation of one of the sublingual ducts; (3) enlargement of a mucous follicle: (4) enlargement of a bursa mucosa, said to exist on the outer surface of the genio-hyoglossus muscle.

FIG. 682.



The same symptoms arise from any such swelling; the tongue is pushed upwards and backwards, or sideways, thus interrupting speech and deglutition, as ordinary ranula attains the size of a marble or a chestnut. An enlarged bursa presents an elastic swelling more under the side of the jaw, and which attains to a larger size, that of an orange or larger. The contents of these cystic swellings differ: a dilated Whartonian duct or an ordinary ranula contains a clear, glairy fluid, like white of egg, with, perhaps, phosphatic concretion; an enlarged mucous follicle is filled with a putty-like matter, consisting of epithelial scales with granular fat; while an enlarged bursa contains a clear, serous fluid, occasionally tinged with blood.

Treatment.—Ordinary ranula may be made to disappear by introducing two or three threads of seton through the front of the sac; the ends are loosely tied, cut off, and the seton left in the mouth. (Fig. 682.) Or the sac may be snipped with scissors, making a button-like aperture, and the interior touched freely with nitrate of silver.

Mucous *cysts* are generally loosely attached, and can be dissected out entire. Enlarged *bursa*, forming in the neck, can be evacuated by a trocar, and injected with dilute tincture of iodine. Or the seton may be here employed; and Mr. Skey passes it through the floor of the mouth to the most dependent part of the cyst.

CHAPTER XLVII.*

DENTAL SURGERY.

The scope of the following pages must of necessity be strictly limited, inasmuch as the many details which enter into the practice of this branch of Surgery could not be described in a general work at such length as to be intelligible. Moreover, the practice of Dental Surgery will of necessity lie mainly in the hands of those who devote themselves to it alone, and, above all, who have received a special education in their subject, without which they cannot render themselves capable, far less excel, in the practice of their profession. Such, however, will not seek information in a brief section like the present, and I the more readily leave out all detail in that, in special works, there will be found described at length many points which will only be touched upon here.

But there is a border land between the provinces of the general and of the dental Surgeon, with which, both for the welfare of the patient and the credit of the practitioner, it is important that each should be familiar. For it often happens that the practitioner of General Medicine and Surgery is called upon to treat maladies connected with the teeth, with which, in the present neglect of this branch of study amongst the many which perplex the general student, he has not the most elementary acquaintance.

The space devoted to Dental Surgery will, therefore, be most usefully devoted to this common ground, to the exclusion in great part of the means adopted for the preservation of the teeth, and other manipulative details. For modern dentistry requires appliances so very numerous and costly, its operations are so lengthy and toilsome—many a gold-filling requiring two or three hours for its completion—and the needful manipulative dexterity so hard of attainment, that such details can have no practical interest for the practitioner of General Surgery. Yet it is in these practical minutiæ that the recent great advances in Dental Surgery have been made,—such advances that the Hospital student of to-day is able to perform operations and get results till lately unattainable by his seniors in the profession; and there is a temptation to descant on these things by way of urging on our professional brethren an acquaintance with, and consequent appreciation of, modern dental science, their present lack of which is a constant thorn in the side of the specialist.

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* By Charles S. Tomes, F.R.S.

DISEASES INCIDENT TO THE DEVELOPMENT AND ERUPTION OF TEETH.

The considerable constitutional disturbance, the symptoms of derangement of the nervous system, and the bodily suffering so often produced by the cutting of the first teeth, hardly fall within the scope of the present chapter. They must not, however, be forgotten by any one who is desirous of understanding the sometimes remote symptoms which may be produced by diseases of the teeth in adults.

When it is necessary to lance the gum in young children, the cut should be a free one, and of a form calculated to give an easy passage to the coming crown. Thus, a longitudinal incision will be sufficient over the crown of an incisor or a canine, whilst a crucial incision is required over a molar. Lancing of the gum is of clear and unquestionable benefit when the gum is thick, tense, and red; it is of more doubtful service when there is no distinct local irritation; but it should, nevertheless, be practised whenever obscure nervous symptoms or convulsions occur at about the period when teeth are due, as there are numerous cases on record of almost instant cure effected by this simple measure.

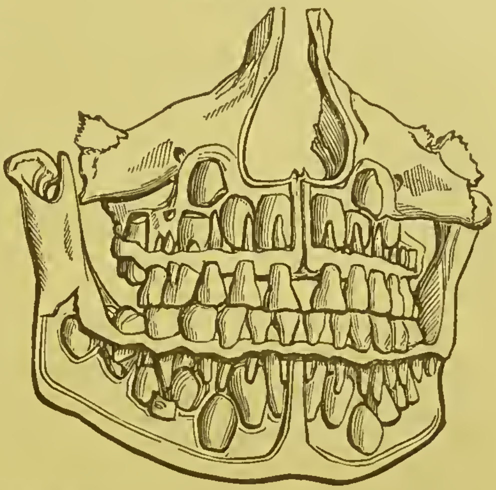
About the age of seven years the temporary teeth begin to be shed. Prior to this, however, the first permanent molars have come up behind the last of the temporary teeth, and take an important part in mastication during the period of change.

When the process is perfectly normal, it may be first noticed that the temporary teeth, originally in close contact, come to be separated from one another by small intervals; then, in a certain definite order, their roots become absorbed, they fall out, and their place is taken by permanent teeth which rise up beneath them.

Of these permanent teeth, the incisors and canines are larger than their predecessors, the premolars (bicuspids) are smaller, but by the help of a slight obliquity of position they are all able to be accommodated in the space occupied by the twenty deciduous teeth.

But it by no means always happens that the due proportion between the size of the teeth and the size of the jaw is maintained; on the contrary, it is exceedingly common for the teeth to be too large to be accommodated in an even regular arch, and it then becomes necessary to remove some member of the permanent series. A great many considerations come into play in deciding which tooth shall be sacrificed. But although it is not possible here to go into any detail upon this subject, one broad fact regarding the development of the jaws must be constantly kept in mind. It is that that portion of the jaw which contains the temporary teeth, practically speaking, undergoes no increase in dimensions from the period of the full complement of temporary teeth being erupted to that of the permanent teeth being placed, all growth taking place by additions to the posterior cornua of the arch. When, therefore, the teeth come down in such manner as to be crowded, there is no hope of the evil being remedied by growth of the jaw, but it must be at once faced and obviated by other measures. A disproportion between the size of the teeth and of the jaws (due rather to deficient growth of the latter than to excessive size of the former) is exceedingly common at the present day, though it is and was all but unknown amongst rude races. In rickety persons the disproportion is even more marked, for the teeth have not participated at all in that stunting which has marred the development of the jaws, in common with the rest of the facial bones; and consequently, in extreme cases, the teeth have been seen arranged in a fan-like shape, their crowns forming a circle of far larger radius than their roots.

Fig. 683.



And it must not for a moment be forgotten that the permanent teeth, during their development, occupy positions which might be termed irregular; that is to say, they overlap one another somewhat, and the canines stand quite above (or below, as the case may be) the line of the others. (Fig. 683.) When they first appear through the gum they may retain something of this normal irregularity of position, which, unless there is something to interfere—such as overcrowding, the retention of unabsorbed roots of temporary teeth, or other mechanical obstacle—will be corrected by nature, so that there is no need for interference.

The judicious extraction of teeth, just at the moment when it is called for, will very often obviate the necessity for the subsequent correction of an irregularity by the tedious process of wearing plates in the mouth; and as it may chance that the operation may be called for where the services of a dentist cannot be commanded, a few guiding rules may be laid down respecting the choice of the tooth to be removed.

If any of the teeth are already decayed the choice would, *cœteris paribus*, fall upon the defective one; and in connection with this, if none are already decayed, it should be remembered that, of all the teeth, the first permanent molars are the most liable to decay, the canines the least so.

The removal of first permanent molars at an early age (*i.e.* up to thirteen or fourteen) will relieve a moderate degree of crowding in the region of the canine, unless the bicuspids are so locked, by their fitting against the teeth of the other jaw, as to be obviously prevented from changing their position.

The canine should very rarely be removed. It is very seldom indeed that its malposition cannot be corrected; it is the most durable of all the teeth, and its pointed character makes its absence specially noticeable.

When in doubt, it is better to remove a tooth too many than to leave any crowding in the mouth. Unless the mouth be an unexceptionally healthy one, and the teeth unusually good, interstitial decay is the sure result of overcrowding.

In the case of the teeth in front of the second permanent molars, the only results of overcrowding are the disfigurement of the mouth and the damage to the teeth occasioned by their pressure against one another; but pain and inflammation are seldom set up. With the wisdom teeth, however, the case is very different. When any difficulty is interposed in the way of their eruption, very severe suffering, often of a neuralgic character, is apt to be produced, and to be accompanied by various reflex disturbances in other parts supplied by the fifth nerve.

The first permanent molar, the second, and the third or wisdom tooth have all been developed in crypts situated beneath and in the base of the coronoid process. When the growth of the jaw proceeds normally, it takes place by its backward elongation; the coronoid process receding, by the coincident absorption of its anterior and the deposition of bone upon its posterior surfaces, so that when the time for the eruption of the tooth arrives, there should be no part of the coronoid process above it to retard its upward progress. But this normal growth of the jaw has often been arrested prior to the requisite space for the wisdom teeth having been provided between the back of the second lower molar and the front of the coronoid process, so that it has to force its way upwards through an insufficient space, or to pass inwards, so as to lie to the inner side of the base of the coronoid process. The upper wisdom teeth, not having similar relation with the bone around them, are less liable to get into difficulties.

The trouble experienced may be limited to pain and other nervous disturbance, or there may be great inflammation set up in the surrounding parts. When a patient, aged from nineteen to three or four and twenty, in whom the wisdom teeth are not fairly up, complains of stiffness about the jaws, of variable pain—sometimes a dull aching, sometimes a neuralgic paroxysm, with days or even weeks of entire intermission—and no other morbid condition can be detected in the mouth, the wisdom teeth may be suspected, even though there be no visible irritation in their region. Pain and sensation of numbness are often experienced about the mental foramen when such trouble is due to the difficult eruption of a lower wisdom tooth.

The diagnosis may be a little difficult, especially in eminently neuralgic or hysterical girls. When a partly hidden wisdom tooth has been discovered, the mouth should be carefully examined to see what prospect of complete eruption the tooth has. If the patient be over twenty, and there be very insufficient space, the offending tooth should, if possible, be taken out; if this be impossible, the second permanent molar should be sacrificed, for deferring the operation will only subject the patient to a continuance of the pain. But when the wisdom teeth are being cut unusually early, it may be worth while to wait for a time, as more space may perhaps be provided. Though pains referred to the whole jaw, and stiffness due to a slight degree of spasm of the masseter, are the most common symptoms of difficult eruption of the wisdom teeth, a great variety of other symptoms may be present. Thus, transient deafness, with pain in the eyeball, sometimes very intense, with or without increased lachrymation, twitchings of facial muscles, ptosis, and many other manifestations of disturbed innervation, are sometimes met with. Epileptiform attacks have even, with a high degree of probability, been traced to this cause.

It is, however, more common to find distinctly marked inflammation in the soft parts surrounding such a wisdom tooth. The mildest form of the affection is that in which the gum overlying the half-erupted tooth, whether from being bitten upon or, more commonly, from the increased tension, becomes inflamed, painful, and extraordinarily tender. Lancing such a gum does not do much good; it should be bodily cut away, and this can generally be effected by two well-directed cuts of a pair of curved scissors, which should be strong but very sharp, and with blunt points, to enable them to be easily insinuated between the gum and the tooth. Very often, however, the gum is not merely inflamed, but is extensively ulcerated, the breath is very fœtid, there is great swelling, the mouth cannot be opened (this is due to muscular spasm far more than to the swelling, and it can generally be opened with comparative ease if an anæsthetic be administered), and the patient's suffering is intense. If it be not relieved, profuse suppuration occurs in the region of the tooth, the pus generally making its way forwards, between the cheek and the teeth, but sometimes pointing near the angle of the jaw (Fig. 684); the lymphatic glands may suppurate, and necrosis of a limited portion of bone in the immediate neighbourhood of the tooth results. The necrosis is occasionally very extensive.

In these cases great mischief may result from delay. There is a prevalent belief amongst the public, and unfortunately sometimes amongst their medical advisers, that a tooth should not be extracted during the continuance of acute inflammation. This belief is quite groundless, and the removal of a tooth should never be deferred for a day on this account, for far more extensive mischief may result from the irritation being kept up than can possibly ensue from the laceration of the inflamed tissues.

So far mention has been made only of minor displacement of the teeth—such as admits of more or less easy remedy. Teeth may, however, be developed in very abnormal situations—the wisdom teeth, for instance, in the sigmoid notch of the lower jaw (Fig. 685), or in the angle of the jaw, looking outwards; or the canines (with their points directed upwards) in the nasal process of the superior maxilla, or in the antrum. Teeth which are thus far removed from their appropriate position are apt to set up much irritation in the surrounding parts, and hence are often the cause of the formation of cysts or partial necroses of the jaws.

FIG. 684.

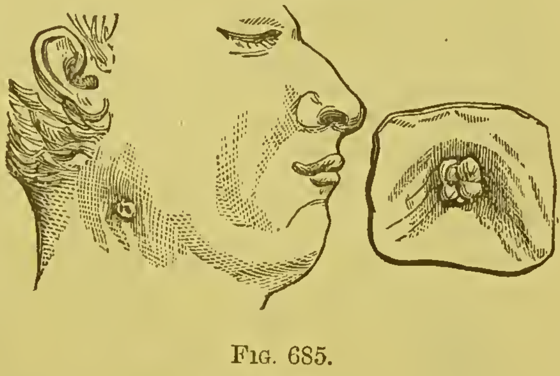
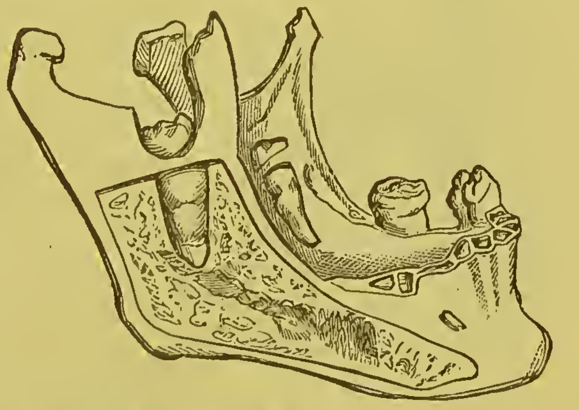


FIG. 685.



Permanent teeth may be wholly absent, this peculiarity being inherited, as has happened in several recorded cases, and gong hand in hand with abnormal hair-development. In the case of the edentulous hairy man exhibited a few years since in London, the absence of permanent teeth was accompanied by a cessation in the growth of the jaw, so that the man, in other dimensions bulky, had alveolar arches no larger than those of the child.

Particular teeth, notably lateral incisors, may be absent, and this is sometimes a family characteristic; wisdom teeth also are not unfrequently absent, or at all events do not erupt; but, although I am acquainted with many cases of inherited absence of lateral incisors, and with a few of bicuspids, I know of no case in which absence of the canines or of any true molar has been inherited.

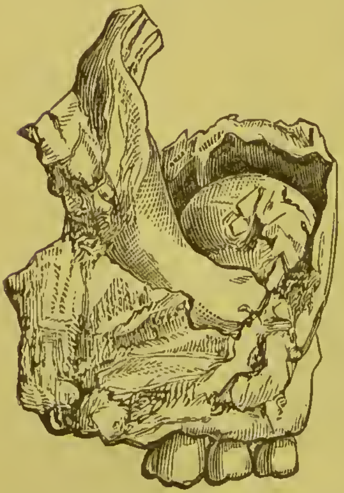
When a permanent tooth is absent, or does not erupt, the temporary tooth may remain and be serviceable through life; it is consequently bad practice to remove it for no better reason than the hope that its absence may facilitate and accelerate the advent of its successor.

On the other hand, there may be too many teeth. When the additional teeth are exact repetitions of some of the normal teeth, they are called "supplemental;" when they are more or less irregular and stunted, or excessively large and shapeless, they are called "supernumerary."

Supernumerary teeth are almost always to be extracted; supplemental teeth only if they interfere with the regularity of the normal teeth, and little difficulty will usually attend their removal, as their roots are generally single and disproportionately small.

Dentigerous Cysts.—A certain portion of the jaw-bones—the alveolar portion—is developed in subserviency to, and wholly devoted to the lodgment of, the teeth. When they fail to take their places in this their appropriate home, they appear to sometimes act as sources of irritation, and to cause inflammation or necrosis of the surrounding bone; or this latter becomes the seat of a painless enlargement, which, when opened up, is found to be a cyst with fluid contents, and a more or less perfect tooth or teeth in it.

Fig. 686.



The tooth may be a perfect tooth, in no respect abnormal, save that it has failed to get into its appropriate place. Such are the teeth in M. Maisonneuve's case (figured in Heath's "Diseases of Jaws," 2nd ed., p. 168), and in Mr. Cartwright's specimen of calcified dentigerous cyst in the antrum here figured (Fig. 686), or in Professor Baume's case (quoted by Moon, Bryant's "Surgery," 2nd ed., p. 540), in which both antra were enormously distended, the one containing a molar, the other a canine. On the other hand, the development of the tooth may have proceeded no further than the formation of a perfect crown without roots; or the process of tooth-development may have been altogether disturbed, and the place of a single tooth be taken by a large number (in one case eight and twenty, besides others which were lost) of detached denticles.

Dentigerous cysts are painless, of slow growth, even outline, and, when the bone is sufficiently thinned, yield a crackling sensation to pressure under the finger. They contain a glairy, transparent fluid, enclosed in a sac of moderate thickness. The teeth which have caused them have been sometimes found loose in the cavity, sometimes very firmly implanted in a portion of the bony wall.

Of course, an important guide to a correct diagnosis will be the absence of one of the teeth from its proper place. It is, however, quite possible that a dentigerous cyst might be found in connection with a supernumerary, so that the presence of the normal number of teeth would not absolutely exclude the possibility of a particular tumour being a dentigerous cyst.

Many instances of needless resections of large portions of the jaw, owing to the true nature of these enlargements not having been diagnosed, are on record.

The constitutional taint of SYPHILIS is capable of modifying the teeth during the period of their development, and of imprinting upon them a characteristic deformity. This was first pointed out by Mr. Hutchinson; it has been doubted by several writers, who have opposed to his conclusions general impressions, and has been confirmed by others, who have closely investigated and have brought forward particular cases; and it may now, I think, be fairly accepted as proven.

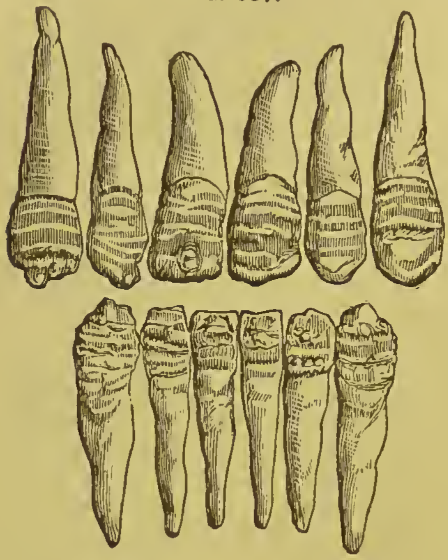
A normal incisor is wider (or as wide) at its cutting edge than at any other point, and is, when unworn, to a slight extent trilobed, having three faintly marked cusps or prominences along its edge. A syphilitic tooth is narrower at its cutting edge than elsewhere, and the edge is concave, without trace of the three cusps. They may thus be described as peg-shaped; and, although the alteration is most striking in the incisors, a similar effect is produced upon the molars by the suppression of the normal cusps, their tops then becoming dome-shaped; but the teeth are not necessarily rugged, nor otherwise defective in structure, as was pointed out by Mr. Moon.

In all the teeth a similar deviation from the normal pattern has taken place. At the period of birth, or soon after, there has been a tendency to the dwarfing and suppression of the characteristic form of the tooth-pulps—hence those portions of teeth first formed are stunted; but, as time goes on, the tooth-pulps attain more nearly to their normal dimensions, and the last-formed portions of the teeth are less aberrant. The canine teeth being later in their calcification than the incisors, have less of their bulk modified, and only their extreme tips are deformed. It was supposed, by Mr. Hutchinson, that this dwarfing of the teeth was due to the somewhat direct influence of stomatitis early in life; but, on grounds which I have given elsewhere ("System of Dental Surgery," p. 217), it seems more probable that the syphilitic poison acts by directly modifying the nutrition of this part, as it does that of many other parts, and especially dermal structures other than the teeth.

The syphilitic origin of this malformation was first suspected through the very constant association of teeth of this form with chronic interstitial keratitis.

Teeth which are called "honey-combed" or "craggy," from the rough irregular incrustation of enamel by which they are incompletely covered, are by Mr. Hutchinson believed to be a result of the administration of mercury* in infancy ("Trans. Path. Soc.," 1875: On Lamellar Cataract and Imperfect Teeth); and his view is endorsed by so careful an observer as my colleague, Mr. Moon ("Trans. Odont. Soc.," 1877). For myself, I have not had the opportunity of forming an independent opinion; but so far all the evidence which has been adduced tends to confirm the accuracy of Mr. Hutchinson's views as to the effect of syphilis and of mercury on the teeth, while nothing at all worth consideration has been adduced on the other side. It would appear, therefore, that syphilis profoundly modifies the form of the formative dentine pulp, while mercury exerts a more limited effect, in hindering the proper formation of enamel without otherwise altering the form and disposition of the constituent parts of a tooth.

FIG. 687.



The tooth-pulps of two contiguous teeth may coalesce at almost any period of their development, thereby, when calcified, forming what is termed a "geminated" tooth. Or, after calcification has gone on for a certain length of time, the cap of dentine may, by violence, be displaced upon the formative pulp. Teeth in which the axis of one portion forms an angle with that of the rest are termed "dilacerated" teeth. I am not aware of this accident having occurred to teeth other than incisors; in them it is not uncommon.

The formative pulp may go astray in its development, and irregular masses of calcified material be added to a tooth in other respects tolerably normal in form. These may be insignificant in size as compared with the tooth, or they may greatly preponderate over it; and the tooth may be stunted, or even not recognizable as such.

These products of abnormal tooth-pulps are termed "Odontomes," and M. Broca has classified them as (1) "Embryoplastic," when arising before the dentine pulp has a membrana eboris and a layer of special enamel-forming cells; (2) Odontoplastic, formed subsequently to the presence of a membrana eboris and layer of enamel cells, but prior to the formation of a cap of calcified dentine; (3) Coronary, while the crown of the tooth is being formed; (4) Radicular, while the root is being formed.

M. Broca claims for many tumours of the jaw (especially encysted fibroid tumours) a dental origin; arguing that, as the dental germ at his "embryoplastic" period contained no enamel cells nor odontoblasts, there would therefore be no dentine nor enamel in the tumours.

But some little acquaintance with the early tooth-germs of man and other animals inclines me to think that M. Broca's classification might be advantageously simplified by striking off the "embryoplastic" group, as odontoblasts occur so very early in the history of the tooth-germ, and enamel cells still earlier; moreover, though these cells exist, it does not follow that they would calcify. M. Robin's famous case, in which a tumour of fibrous structure bore upon it many papillæ, insignificant in size, which carried little dentine caps, is but one step removed from a fibrous tumour with no characteristic dental structures in it.

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* Stedman's popular teething powders contain a considerable quantity of calomel.

"*Odontoplastic*" *Odontomes.*—These may, perhaps, sometimes be fibrous tumours, with nothing to point to their dental origin save their position; or they may be irregular calcified masses, varying from the size of a pea to that of a hen's egg (Forget's case), made up of a chaotic assemblage of dental structures. They may for years remain in the mouth, and even become worn down by mastication; ultimately, however, they generally set up sufficient irritation to necessitate their removal, if they are not ejected by suppuration around their imbedded portions.

A remarkable calcified tumour (Fig. 688), which has invaded and embraced the root of a lower molar, may perhaps be an odontoplastic odontome; unfortunately, no history is obtainable with this unique specimen, which was lent to me by Dr. Barrett, of Buffalo.

FIG. 688.

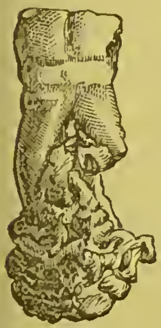
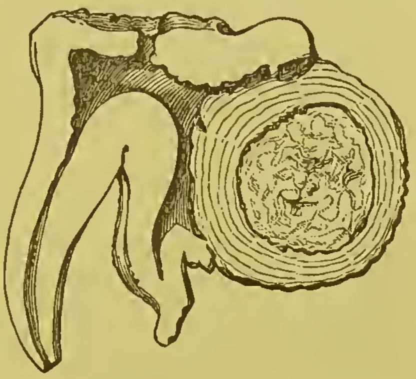


FIG. 689.



The accompanying figure (Fig. 689) represents a section of a coronary odontome. An examination of this specimen suggests that a globular new growth had formed in the interior of the formative pulp, inside the membrana eboris, which in its growth it had first thrust before it, and afterwards burst through, remaining however inside the tooth-capsule, from which it, in common with the rest of the tooth, has received an investment of cementum.

This, as well as an enormous odontome attached to a horse's molar (in the Odontological Society's Museum), is much worn by mastication, so that it evidently long remained without causing irritation.

In a specimen lately shown me by Mr. Moon—which will be described in Guy's Hospital Reports—there is also a deeply worn facet, though it was ultimately removed on account of suppuration and much inflammation about it.

In Bryant's "Surgery," 2nd ed., p. 516, there is figured a remarkable example of dilatation of a root, the crown of the tooth remaining normal.

DISEASES INCIDENT TO COMPLETED TEETH.

DENTAL CARIES AND ITS CONSEQUENCES.—By far the most frequent cause of pain and ultimate loss of the teeth is caries, a disease of which the exact cause is still unknown to us. Amongst rude uncivilized races it is, and always was, almost unknown; amongst civilized people, even living in the same climate, it was always prevalent, as is instanced by the Ancient Britons and the Romans in England. And though it has for so long been prevalent amongst civilized people, there is little room for doubt that it has become more so in the last three or four generations.

With no exception, it commences on the exterior of the tooth and proceeds inwards; there is never a lesion of the dentine without a perforation in the enamel leading down to it. This perforation in the enamel may be a natural defect, or may be the result of caries; but when once the dentine is reached, the progress of disease is more rapid, and it spreads laterally, so that a large cavity in the dentine may be approached through quite a small perforation in the enamel.

In dental caries the lime salts are dissolved and the dental tissues thereby rendered soft. This may be effected by almost any acid; and by the use of particular acids the phenomena of caries may be pretty closely imitated out of the mouth. All the destructive process is a purely chemical one, and the vital powers of the tooth come into play solely in the attempt to bar out the mischief in a manner to be presently described.

The acids which, in actual experiments, best reproduce the appearances of dental caries, are just those which may easily be produced in the mouth by the fermentation of saccharine and other matters, such as malic, citric, acetic, and propionic acids. For the development of such bodies time is necessary; the morsel of food or mucus must have lain undisturbed in some cranny till the change was completed, and hence it is that perfect cleanliness is the best possible preventive of decay, and that a tooth isolated from its fellows comparatively seldom is attacked.

Anything which vitiates the secretions of the mouth, increasing the quantity of viscid mucus or decreasing the secretion of limpid saliva, thus tends to the development of caries; hence its prevalence in dyspeptics and in those who have recently suffered from acute disease.

But, although early loss of the teeth is often indicative of imperfect health, very extensive caries may be sometimes met with in persons who present no other indication of departure from the standard of perfect health and strength.

Caries is especially prone to occur where there is any fissure or pit in the enamel; it occurs with great frequency also upon the surfaces of contact, when teeth are unduly crowded, probably because the enamel at such points gets injured during the slight movements of the tooth in mastication. The progress of the mischief is at first comparatively slow, but when once a cavity has been established in which foreign matters can lodge, it becomes far more rapid. At first, little or no pain is felt, except the cavity be in such a position as to be frequently touched in mastication or in cleaning the teeth; but as the mischief approaches more nearly to the central pulp-chamber, there is at first tenderness to change of temperature, and then slight aching.

If nothing is done for it, the softening extends into the pulp-chamber, exposing the nerve, which itself becomes diseased, and may or may not give rise to violent toothache. Eventually the nerve dies (either suddenly in mass, or wastes away by suppuration upon the surface exposed), and an alveolar abscess probably ensues.

The greater part of the time of the dental Surgeon is occupied in arresting the ravages of caries by filling teeth, but it would be out of place to describe in these pages the details of this operation.

The most favourable period at which the operation can be performed is at the commencement of the disease, when the cavity is not of such size as to materially diminish the strength of the sides of the tooth, and before the pulp-cavity has been approached. In general terms it may be said that when decay has so far advanced that the tooth has begun to ache, the really favourable period for filling it has gone by, and this cannot be too strongly impressed upon all concerned.

The preparation for filling, under favourable circumstances, consists in the complete removal of all softened tissue and of all very frail edges. If the cavity so formed be not of such shape as to retain a filling when inserted, undercuts must be made at some points, or the cavity be made at least as large inside as at its orifice. If much undercut exists, the orifice should be enlarged, else it will be less easy to fill it solidly.

Many materials are used for filling teeth, of which the following are the principal:—

Gold—in the form of leaf, or of a crystalline precipitate. If inserted with adequate skill, to which but few practitioners fully attain, it is the best material that can be used. The insertion of a difficult gold-filling may take one, two, three, or even more hours of pains-taking and laborious work.

Amalgams, which are combinations of various metals with mercury, inserted in a plastic condition, and allowed to harden *in situ*.

Of these, the metal palladium forms the best, but it is difficult to use, and turns black in the mouth. Copper forms an amalgam in some respects good; it turns black and stains the surrounding tooth-substance black, but the stained tissue is in great measure protected against further decay.

In general usefulness, amalgams consisting of silver and tin, with a small percentage of gold and platinum, carry the palm. These have been much improved of late years.

Gutta-percha, with which is incorporated powdered glass to give it greater hardness, is an excellent temporary filling, its durability being principally determined by the amount of attrition to which it is exposed. In a sheltered position it will last for many years.

Oxychloride of zinc, also containing more or less powdered glass or other such material, is another useful temporary filling. It is more or less rapidly softened by the fluids of the mouth, and where it touches the gum its speedy destruction is certain, but if it be tolerably remote from the gum it will often last a long time. It affords more support to the frail walls of a greatly damaged tooth than any of the other fillings.

If the size of the cavity be such that the pulp is at all nearly approached, a metallic filling should not be inserted. If a non-conducting filling be inserted, and so time gained, the pulp will protect itself by fresh calcification upon the point threatened with exposure, and after this has happened a metallic filling may be inserted without fear of alternations of temperature so irritating the pulp as to set up disease in it. When decay has approached the pulp somewhat nearly, this ceases to be healthy, and before the tooth can be filled the diseased condition of the pulp must be considered and remedied.

It may happen that, in the course of excavating a cavity, the pulp may be accidentally exposed by the cutting instrument employed. This mishap modifies the further procedure in filling the tooth. If the pulp has not previously ached, and is hence presumably healthy, the tooth may nevertheless be filled at the same sitting.

The surface exposed should be well swabbed with deliquesced carbolic acid, till its pink surface is whitened, a cap of some inoffensive non-conducting substance adjusted, and the cavity filled with such care so as not to dislodge the cap. For this purpose oxychloride of zinc is the most generally suitable filling, as it is so soft and plastic when first mixed, that it can be introduced without pressure; gutta-percha may also be used, and, under exceptionally favourable circumstances, gold or amalgam.

For the cap many different substances are used—a paste of oxide of zinc and carbolic acid; a slip of absorbent paper moistened with carbolic acid, or, if an oxychloride of zinc filling is to be used, with carbolic acid and oil; a piece of quill (not so good on account of less ready adaptability), and many other non-irritant substances; and finally oxychloride of zinc filling itself, which is painful, and in no respect preferable to the others. A pulp thus treated is said to be "capped," and the object with which this is done is to give it time to calcify at the point of exposure. In a thoroughly successful case, when the temporary filling is removed nine months or a year after its insertion, the pulp will no longer be exposed, but a plug of secondary dentine will occupy the former point of exposure, and the tooth can be permanently filled.

Perhaps no more convenient place will occur for noting the measure of success which attends the operation of filling teeth, if thoroughly and skilfully performed.

A tooth filled before caries has advanced too far is, if the operation be quite perfect, restored to a condition as sound as that it enjoyed before it began to decay; but inasmuch as it originally decayed when it was sound, so it may again. Teeth are, however, specially prone to decay in certain situations, whether from the existence of original pits in or through the enamel, or from the position being otherwise favourable for the attacks of caries; but when decay has happened in these positions, has been cut out, and a *perfect* gold-filling substituted for the lost tooth-substance, that tooth will be less obnoxious to the attacks of caries than it originally was, inasmuch as its weakest spots will now be of gold, and be incapable of decay.

Good fillings will protect teeth frequently for twenty or thirty years—for an unlimited time, in fact—but, as may be gathered from what has been said above, such results cannot be uniformly secured. Firstly, there is the carelessness of the patient, who very frequently neglects to come until the most favourable period for inserting the filling has gone by; next, the enormous difficulty of making uniformly good fillings, a difficulty the extent of which no one who is not constantly contending with it can form any idea of. Then there are many teeth in themselves so defective that they are full of weak places, liable to speedy decay; and there are many mouths in which the tendency to caries is so great that it seems almost hopeless to contend with it. In such mouths (generally in young people, hardly adult) the saliva, or rather the secretion of the gums, is very viscid, and the latter are red and spongy.

The only encouraging feature of such cases is that the mouth often becomes more healthy as the patient becomes older, so that if the period of excessively rapid decay can be tided over, a less amount of attention will be required in after years.

For such cases gutta-percha is the most generally useful filling, as, from the exceeding tenderness of the teeth, it is difficult and hardly possible to make good gold-fillings. Oxychloride of zinc forms an admirable temporary filling, but it requires renewal even more frequently in such mouths than in healthy ones.

If the cavity of decay be neglected, *inflammation of the pulp* is the most common result of the approach of caries. A tooth which has been sensitive to heat and cold, and has from time to time ached slightly, suddenly becomes the centre of most violent pain, every pulsation of its vessels giving rise to an extra throb. After excruciating pain has lasted for some hours (it may be a day), it ceases, sometimes gradually, more generally suddenly, and the pulp is found to be dead.

Such are the symptoms of acute inflammation of a whole pulp, a disorder which almost always ends in its abrupt death; but local inflammations of the pulp-substance, confined to the point of exposure, and often not larger than a millet seed, often exist, and may go on for months without involving the rest of the pulp.

Such spots of inflammation are especially prone to set up neuralgic pains, which do not seem to have any connection with the teeth, and they do not often cause excruciating toothache distinctly referable to a particular tooth.

The morbid change may go further, and the exposed spot ulcerate; in this way the pulp becomes wasted and no longer fills up the whole pulp-chamber, and in course of time altogether disappears. This condition of the pulp, when, from the position of the cavity, foreign matters do not reach it, is not necessarily attended with pain.

When the dentine is softened down to, or nearly down to the pulp, but yet there is no positive exposure, the pulp often passes into a condition known as "irritation" of the nerve. The pain in the tooth, if any, is moderate, and there is perhaps more general uneasiness in all the teeth than pain in any particular one. But there is greatly exalted sensibility in the tooth; it is very sensitive to changes of temperature, even though a sound surface of the tooth be touched, and it is tender to a jar. It is ready, at short notice, to pass into the condition of acute inflammation, in which the patient, previously afraid of the smallest variation of temperature, seeks relief by holding iced water in the mouth. Whenever a patient seeks to get relief from cold, the source of the pain is almost certainly an inflamed tooth-pulp.

Irritation and subsequent inflammation and death of the pulp may take place without any exposure of the nerve, and even without caries; thus, it not infrequently happens subsequently to the insertion of a filling, even where there has been no exposure of the pulp, and it is common in teeth which have become much worn down.

When the pulp is in a state of acute inflammation, the orifice of exposure should be, if possible, sufficiently enlarged to allow of perfect application of the remedy to its surface, and the pulp destroyed by a dressing of about one-sixteenth of a grain of arsenious acid, applied on a tiny pledget of cotton wool, and carefully sealed in the cavity by gutta-percha, wax, or a large piece of wool dipped in an alcoholic solution of gum sandarach. This will usually cause the death of the pulp in a few hours, but may with advantage be allowed to remain in the tooth for two days, when it should be removed, and the pulp, if dead, thoroughly removed, both from the pulp-chamber and the roots. When the tooth is subsequently filled, the pulp-canals in the root have to be very carefully filled up, and on the completeness with which this can be done the subsequent success of the operation will largely depend.

When a considerable portion of the pulp has been lost by suppuration from the exposed surface, the same treatment, viz., its destruction by arsenious acid, will yield the best result.

When, however, there is no large exposure, no loss of substance of the pulp, no neuralgia, and no considerable pain, but signs only of slight chronic inflammation or irritation of the pulp, it may be often preserved alive. Dressings of undiluted carbolic acid form the best application, varied sometimes with tannin and with creasote. By means of these the pulp may be brought into a normal condition, and the tooth filled, as if with an accidental exposure of the pulp (see page 316).

But when a pulp has been for some little time in a diseased condition, it is very apt to give trouble and even to die under the filling; and, with our present knowledge of its treatment, I do not think it worth while to attempt to preserve a pulp alive which has long been painful.

Mention has been made above of *calcification* of the pulp taking place as a protective measure; but under certain conditions, not thoroughly understood, calcification of the pulp is capable of giving rise to very great pain. This seems especially prone to occur when isolated nodules are formed, or when the pulp calcifies almost *en masse*, but the new dentine is not in continuity with the old, it lying loose in the pulp-cavity.

Calcification of the pulp may happen in otherwise sound teeth, especially in advanced life, and may be the cause of much neuralgia. It can only be detected by the exclusion of all other causes of pulp irritation, and often cannot be diagnosed till after the extraction of the tooth.

On the other hand, loose nodules of calcification are frequently met with in teeth which have never caused the slightest annoyance, so that the conditions under which they do or do not cause irritation remain uncertain; perhaps it may have to do with the accident of nerves being involved or interfered with by the growing hard masses.

In advanced life the pulp may undergo a sort of senile degeneration; its vessels become plugged, its odontoblasts disappear, and fatty degeneration occurs in its nerves and other structures. This is a painless process, generally associated with the loss of the teeth by absorption of the sockets.

By *Polypus of the pulp* is understood an outgrowth from its exposed surface, which may be as large as a pea, and fill up the whole cavity of decay. It is fibrous in structure, insensitive to touch, and often secretes an offensive discharge. The tooth can seldom be saved by destruction of the pulp, as the nerve-canals of the root are commonly much enlarged, and the exterior of the root also diseased.

Alveolar Abscess.—When the tooth-pulp has died, and the whole or any portion of it has remained behind to decompose in the cavity of the tooth, the products of decomposition escape at the apical foramen of the root, and set up violent inflammation; so that ultimately an abscess forms, the sac of which embraces the point of the root, which lies bare and bathed in pus.

It is therefore an inflammation, very violent, though limited, set up by the extrusion of a septic fluid from the end of the root; and the first care of the dentist is to remove every particle of dead nerve, and to pump carbolic acid well up into the root, so as to render harmless any tiny fragment that might remain; or, if the pulp is already decomposed and liquefied, to take care that his instruments do not act as pistons, and force out at the end of the root septic fluids prior to their having been rendered harmless by carbolic acid.

The first stage in the formation of abscess is a periostitis of that common periosteum which clothes tooth-root and bone of socket alike; owing to swelling of this, the tooth is slightly elevated and pushed up out of its socket, so that it has increased mobility. The tooth will be tender when bitten upon,—tender to any jar, but not so tender but that the patient feels rather disposed to bite firmly upon it, and press it home from time to time. Next, the soreness becomes much greater, and tenderness is perceptible on pressing upon the exterior of its alveolus; it becomes much more painful, and severe throbbing sets in, followed by swelling and the formation and ultimate discharge of pus. The pain usually moderates with the appearance of swelling, and the discharge of pus takes place by an opening through the alveolus and gum over the end of the root, or in the sulcus between the cheek and the teeth; or it may find its way to the surface and burst externally, or through the tooth itself, or between the tooth and its socket. There are all degrees of alveolar abscess, from one which comes with so little pain as to be hardly noticed, to one which causes such swelling of the face and febrile disturbance as to look almost like an erysipelatous attack.

The *treatment* is to obviate the cause by thoroughly impregnating the pulp-cavity with carbolic acid, so as to render harmless what it may contain; and, if it be in an early stage, to paint the gum over with equal parts of tincture of iodine and aconite, several times in the day. If it has gone on to the formation of matter, also give exit to it at once, lest it burrow and the abscess break externally.

An acute alveolar abscess often terminates in a chronic gumboil; instead of healing, a small fistula remains, through which a very small amount of pus discharges. If the gumboil be at all recent, it may as a rule be speedily cured, especially if there be a fistulous opening close to the end of the root. In that case, if the root-canal be of sufficient size, carbolic acid can be pumped down through the canal and made to pass out through the gums. When it can thus be thoroughly cleansed by an antiseptic, its healing speedily follows. The root can then be filled, and the crown-cavity subsequently dealt with.

But there are many cases of alveolar abscess in which, from the long-standing alteration in the surrounding part and in the root itself (which becomes exostosed, etc.), or from the size and shape of the roots rendering it impossible to get instruments down them, extraction of the tooth will finally be resorted to.

And there is an intermediate class of cases, in which the alveolar abscess cannot be entirely healed and the parts rendered so healthy, that there is absolutely no discharge, and the roots can be filled, but which are nevertheless not painful; these admit of being dealt with in another manner.

If the pulp-cavity of such a tooth be thoroughly cleansed and disinfected, and the tooth filled without filling the root and pulp-cavity, it would soon become painful from the resumption of greater activity in the slumbering abscess, due to a retention of its secretion. But if a very fine hole be drilled in the pulp-cavity, entering the tooth just beneath the margin of the gum, so that food may not easily get into it and close it up, such a tooth will often remain comfortable for years.

This operation is called "Rhizodontropy," and is useful in certain cases; it is, however, only a compromise, much inferior to complete fang-filling, and is to be regarded as a last resource prior to extraction.

Alveolar periostitis and abscess may lead to other untoward results, such as suppuration in the antrum, necrosis more or less extensive, fistulous openings on the face which may involve a salivary duct, etc.

Abscess of the Antrum is, in the vast majority of instances, due to alveolar abscess involving the root of a tooth, which either pierces the bony wall, or at all events comes into very close proximity with the cavity of the antrum. The first and second molars and the second bicuspid have their roots close to the floor of the antrum in almost all cases, but the antrum being variable both in form and size, the canines may also reach up to it; the points of the roots may actually pierce the bone, and be covered only by its mucous lining. Alveolar abscess, excavating out a cavity in the bone, may enter the antrum even when it originates about a lateral or central incisor, so that any tooth whatever may be concerned in the mischief.

The symptoms are a considerable amount of dull, wearing pain, often accompanied by neuralgic pains over the whole side of the head; tenderness of the cheek, especially over the canine fossa, and eventually œdema. Sometimes there is feverishness, sometimes not. The pain, tenderness, and swelling are much greater than are apparently accounted for by the condition of any tooth found to be affected. Sometimes the discharge, which is apt to be very offensive, makes its way into the nose, and may find its way out at the nostril or backwards into the throat. That it does not more often find its way out by the normal orifice of the antrum is believed by Otto Weber to be due to the suppuration taking place, not in the cavity of the antrum, but between its mucous lining and the bone.

Suppuration in the antrum may go on for a long time, both before and after the evacuation of the pus; in the former case, the diagnosis from a solid tumour may be difficult.

The walls of the antrum, when distended by fluid, yield most easily towards the canine fossa, next towards the orbit; but the great variability of the antrum renders it impossible to rely much upon the relative thinness of its several walls as a means of diagnosis. The lachrymal duct is usually not closed, whereas in fibroid or encephaloid disease in this situation it generally is.

In examining the teeth it should be remembered that not only may any dead tooth be the source of trouble, but a sound and living tooth, one or more of the roots of which are affected by absorption and exostosis (*cf.* page 322), sometimes causes suppuration in the antrum.

The *treatment* of the disease consists in freely opening up the antrum. This may generally be done best by extracting the offending tooth, and enlarging, if necessary, the opening thus formed. If there is no tooth at the root of the mischief, the first molar is the best to extract for this purpose. Dr. Bogue, of New York, successfully treated a case of long standing by drilling through a tooth and its roots up into the antrum, and syringing the cavity through the canal thus formed; but I doubt whether the ultimate conservation of the tooth, which would be far from certain, would repay the patient for the extra time over which the treatment would extend.

Oftentimes free vent being given to the pus alone effects a cure, but should it fail to do so, mild astringent lotions should be used to wash the cavity out two or three times a day. This the patient may be taught to do by the help of a glass syringe connected, by a short piece of rubber tubing, with the end of a gum elastic catheter of as large size as will enter the orifice. As a rule, there is little trouble if the opening be large; and if an offensive discharge continues for any length of time, it is probable that a piece of dead bone, or some foreign body, is keeping up the irritation. It must not be forgotten that the coincidence of a second tooth, with abscessed roots entering the antrum, is not impossible. A case of this kind occurred in my own practice, and was only detected by me after many months, by passing a bent probe into the cavity, and feeling over the walls, when it struck on the bare roots of another tooth, the next to the one which had been the original cause. The removal of this brought about an immediate cure.

Care should be taken that food does not enter the orifice made. This may be closed by a plate fitted over it, or by temporary plugs of wax, which often answer the purpose, but are liable to the accident of being pushed in, and being then difficult to remove. Roots or fragments of roots may be driven up into the antrum in the attempt to extract them. They should always be got out, as their presence there is sure to set up an offensive discharge. Strong syringing will generally bring such things away, if the orifice be sufficiently patent.

A case of abscess of the antrum, resulting in a discharge of pus between the eye and lower eyelid, and in complete blindness for thirteen months, was traced to a splinter (probably of a tooth-pick) pushed up through the apical foramen of the roots of a dead first upper molar. Complete recovery ensued.

Several cases are on record of blindness, temporary or permanent, ensuing upon antral abscess. Death has been known to ensue from a neglected antral abscess.

Simple cysts may occur in the antrum (Hydrops antri), or dentigerous cysts may be found in the same situation. The absence of any one of the teeth would always lead to the suspicion that an enlargement of the maxilla was due to the latter cause.

The inflammation originating about the root of a tooth may spread very much more widely, and the periosteum covering the outer surface of the jaw become involved, so that large accumulations of matter may take place beneath it. The pus, if not evacuated by nature or by an incision within the mouth, may form an opening on the exterior of the face, and a fistulous track remain for an indefinite length of time. When a lower incisor has been involved, the fistula is found about the chin, generally in front of, but in one case, at all events, behind the edge of the bone. These fistulæ almost always heal at once when the tooth or stump is removed; but when the track is very hard and fibrous, and ties down the fistulous opening so tightly as to be an extra disfigurement, its subcutaneous division from the mouth is a very serviceable procedure,—the patient carrying out the treatment by freely moving the soft parts about with the finger for some time afterwards, so as to secure the permanence of the increased mobility.

Necrosis, very partial or very extensive, may follow up alveolar abscess and periostitis of the general periosteum. Its treatment does not call for any special notice here, except that it should always be borne in mind that a great amount of repair is effected, and that teeth apparently hopelessly loose will oftentimes becomes firmly fixed and again useful after the sequestrum has been removed and bone formed; so that teeth should only be removed if their whole sockets, and not only one side of them, are involved in the sequestrum, or if they have been the originators of the mischief. An exceedingly interesting specimen exists in the Museum of the Bellevue Hospital, New York, in which the entire lower jaw was reformed after necrosis and its removal.

Abscesses originating about teeth may burrow, reaching down the neck as far as the clavicle, and below it. Death has resulted from alveolar abscess and its sequelæ in a good many recorded cases; one of the most remarkable being one of Mr. Howse's (*Med. Times*, 1876), in which suppuration in inferior dental canal, acute periostitis of posterior half of lower jaw, and extension of inflammation into the orbit *viâ* the pterygo-maxillary fissure, resulted in a slow pyæmia. In its chronic stage, the duration of the disease was five weeks; in the acute, nine days.

Dr. Harrison Allen, of Philadelphia, saw a case in which, as a sequence of alveolar abscess about a lower wisdom tooth, ostitis and periostitis of the neighbouring bone ensued; abscess beneath the mylohyoid occurred, the pus gravitating as far as the hyoid bone, and creeping up on the outside of the jaw along the line of the facial artery. After four days the patient died from suffocation, due to enormous œdema of the one side of the tongue and associated parts. Mr. Pollock ("Trans. Odont. Society," 1876) relates a case in which he was driven to perform tracheotomy in consequence of the swelling produced by an abscessed tooth.

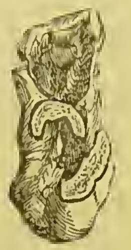
Exostosis.—The roots of teeth are very liable to become affected by exostosis; that is to say, by an undue and localized deposition of cementum, which leads to nodular enlargements of the ends of the root, or to irregular but smooth deposits upon its sides. Exostosis is a frequent result of long-continued periostitis about a dead tooth, which has never gone so far as suppuration; but it is also pretty frequent, especially after middle life, in teeth the crowns of which are perfectly healthy. A small, and sometimes even a large, amount of exostosis may exist without causing the smallest inconvenience; on the other hand, it sometimes causes very severe neuralgia, and this under conditions not visibly different from those in which it does not do so.

Its existence in teeth which are sound is exceedingly difficult to diagnose. Some degree of tenderness to rough handling or to a blow, or when it is bitten upon hard, will often be all that is to be found, even in neuralgic cases. The patient's age, the absence of all other lesions, the connection of the teeth with the neuralgia having been indicated (*cf.* page 328) by various signs, and above all the occurrence of exostosis in other sound teeth which may have previously been extracted, will point to the probability of its existence. Uneasy sensations often exist in and about the particular tooth, sometimes tenderness to changes of temperature, but the diagnosis is very uncertain. This much may be said, however, that if, in a person past middle life, neuralgia can be traced to a sound tooth which is found after extraction to be exostosed, the prognosis, as far as the teeth are concerned, is very bad; for the disease will probably attack other, or even all the remaining, teeth in succession.

Occasionally exostoses take the form of sharp-pointed excrescences from the root of the tooth, and such growths have, in some instances, been the cause of severe neuralgia.

The roots of teeth which have long been in an irritable condition are found to be attacked by absorption in some places, while there is deposition going on at others. The accompanying figure (Fig. 690) shows the extent to which the roots of the tooth have been altered by such inflammatory processes. The apices of the roots, instead of being smooth and rounded, may become jagged and sharp, this alteration being often recognizable by touch of the finger before it is conspicuously visible to the eye.

Fig. 690.



The roots of the teeth which are being lost through old age become roughened by absorption; but the process often occurs in middle life, and is then more rapid, and attended by pain and tenderness in the surrounding parts, and by neuralgic pains.

The discharge which exudes from the gums round the necks of teeth which have passed into this hopeless condition is offensive but not abundant.

It has been supposed that these and analogous morbid conditions of the roots and sockets of teeth are caused by tartar intruding itself between the tooth and gum, and getting down into the sockets; but there must be a separation before the tartar can get there, and its presence, though it serves as an irritant and aggravates the disease, must be regarded as an accident; for instances may be found in which absorption of the sockets, and to a less extent of the roots, has gone on till the tooth is so uncomfortable as to lead to its extraction, in which no tartar is to be found. On the other hand, tartar is capable of bringing about the loosening of the teeth, though in a slightly different manner, so that two distinct morbid conditions, under which the teeth loosen in their sockets and themselves become to a slight extent absorbed, must be recognized.

Tartar is a deposit mainly consisting of salts of lime, mixed up with some organic matter, which are deposited upon those parts of the teeth least exposed to friction. Analyses differ, as might be expected.

The largest deposits of tartar take place upon the backs of the lower front teeth and upon the upper molars, these teeth being near to the orifices of salivary ducts; and if the accumulation is allowed to remain, the gum recedes before it, the edge of the socket is absorbed *pari passu*, and eventually the tooth falls out, loaded with tartar up to almost its very apex. But no pain, and no considerable absorption or roughening of the root, takes place. The process is a slower and more mechanical one than that which has just been spoken of as leading to the premature loss of teeth.

In some persons the teeth become very deeply grooved on their outer or labial surface, just at the level of the gums; this grooving, it is possible, may be produced by mere mechanical abrasion of the surface under the tooth-brush and tooth-powder, especially when the gum has receded so as to expose the tooth beyond the limit of the enamel. But it is far more probable that the surface is first softened—decalcified, in fact—by the secretion of the gums, and subsequently mechanically removed; and that there is no softened layer simply because it is rubbed away as fast as it softens. And that a somewhat closely similar effect can be brought about without the use of the tooth-brush is shown by its occurrence in certain seals.

Besides loss of substance thus brought about, the teeth may be wasted by their whole surface being attacked. Of this rare form of erosion I have seen two instances; the one in a case of acute dyspepsia, the other in the case of a young lady accidentally poisoned, with the effect of leaving long-continued gastric irritation. In the worst case the teeth were very tender, in the other there was no alteration of sensibility of the teeth; in both there was marked loss of enamel, just as though the crown of the teeth had been immersed for a short time in acid, and the enamel which remained had lost polish to a slight extent. Little more than an average amount of caries has occurred in the first-mentioned case, recovery to perfect health having been speedy; in the second case sufficient time has not elapsed to enable me to speak upon this point.

The rational treatment would seem to be the free use of alkaline washes, but in most cases the mischief would be done before it was discovered, and it is doubtful whether we could successfully combat the perpetually reproduced acidity by washes used at intervals.

Diseases of the Gums and Alveolar Processes.

Extensive caries of the teeth is very commonly associated with, if not caused by, a highly vascular, soft, swollen condition of the gums, which secrete abundantly a highly viscid saliva. Though this state of things is usually associated with general derangement of health, and particularly of digestion, the use of mildly alkaline and astringent tooth-powders and washes seems often markedly beneficial.

The thin edges of the gums, where they come into contact with the teeth, are liable to a form of creeping ulceration, very painful and tender, and oftentimes accompanied with much neuralgic pain in the side of the face. When neglected, these ulcers may become extensive, and the cheek, where it comes in contact with them, may also ulcerate. This sometimes occurs in otherwise healthy persons, but is more common in the debilitated. Besides attention to general health, chlorate of potash should be given (best in the form of lozenges), but the main reliance must be placed upon the immediate destruction of the unhealthy surfaces. A single application of a solution of nitrate of silver (a drachm to the ounce) will generally bring an ulcer into a healing condition; but the mouth should be carefully searched every day, and every fresh spot at once touched, as well as any old ones not presenting healing margins. With such care the cure is speedy, but, if neglected, it may drag on for weeks. A trivial source of irritation, such as an abrasion or other injury to the gums, or a half-erupted wisdom tooth, may serve as a starting-point for this form of ulcerative stomatitis, which, in a severe case, may extend all around the mouth and even the palate—in rare cases resulting in extensive necrosis of the subjacent bone; in one case, at least, in death.

Ulcerations of the gums and inner surface of the lips, occurring in syphilitic persons, affect very much the same spots, but differ in the more sluggish appearance of the ulcers, and in the comparative absence of pain and tenderness in the parts affected.

Another form of ulcer occurs upon the inner surface of the lips and cheek, or upon the gums over the root of the teeth, far from their edges. This is of frequent occurrence in some individuals, has little or no tendency to spread, and does not infect the surfaces which touch it, and is generally cured by a single application of nitrate of silver. It originates generally in the follicular glands.

A condition of chronic inflammation of the gums exists in uncleanly mouths, and leads to the premature loss of the teeth; a similar condition accompanies the loosening of the teeth in advanced life. It is somewhat intractable; the teeth, with their roughened and slightly absorbed roots, acting as a constant source of irritation. Those teeth which are past usefulness should be removed, all tartar removed from those which remain, and astringent applications, such as the glycerine of tannin, had recourse to; by these means the usefulness of the teeth may be appreciably prolonged. Tartar is not often the cause of the loosening of the teeth, but its presence, by setting up extra irritation, greatly hastens their destruction when the gum has once begun to separate from them.

The gums are subject to hypertrophies. Limited tumours, more or less pedunculated, may spring up between carious teeth, occupying the cavities of decay, or may thrust themselves up between the stumps of a decayed tooth. Such "polypi" of the gums generally spring from the alveolo-dentar periosteum, close to the edge of a socket, and differ hardly at all from normal gum in histological character. The extraction of the tooth involved will often be desirable, and the polypus may come with it; if the extraction of the tooth is on any account unadvisable, the growth may be cut away and the stump destroyed by escharotics, but it generally recurs.

No hard and fast line can be drawn between polypi of the gum and *epulis*, the name usually applied to non-malignant broad-based growths of the gum. Like polypi, they spring from the periosteum, and recur unless this also is removed; so that, for the cure of epulis, a portion of the alveolar border of the bone is generally removed with cutting forceps. The use of the dental drilling engine, carrying very small circular saws, renders it easy to remove portions of the alveolar borders and of the periosteum, without sacrificing the teeth; by its help an epulis can oftentimes be efficiently extirpated with no further injury to the teeth than the removal of a portion of their sockets, which is practically found not to interfere with their fixation. Sometimes epulis seems distinctly to be caused by the irritation of diseased teeth; sometimes its origin is as clearly independent of any such influence.

General hypertrophy affecting the whole gums and alveolar border is a comparatively rare disease. It is a pure hypertrophy, commencing generally early in life, the teeth sometimes participating in the excessive development, and sometimes being of normal size. It may produce great deformity, as in the case of Julia Pastrana, the "pig-faced" woman, a model of whose mouth is here figured. (Figs. 691, 692.) When the growth is of such size as to call for interference, it may be removed by operation, the masses being pared away with a scalpel, or, if necessary, with bone-forceps.

In a case (f. æt. 15) which came under my own notice, the disease had affected a portion of the upper jaw only, but was increasing rapidly both in bulk and extent. The mother of the girl had suffered from it to the extent of its producing great deformity, but was dead; and the child's relatives would not assent to any operative interference,

FIG. 691.

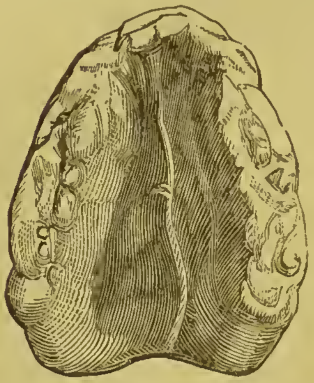
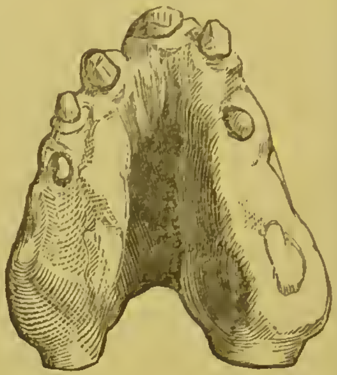


FIG. 692.



which will doubtless have to be resorted to hereafter, on a more extensive scale, and which might, perhaps, have arrested its further spread.

Long-continued irritation about the roots of a tooth will sometimes give rise to a thickening of the bone around it. These enlargements of the bone are generally slightly tender on pressure. Another form of exostosis (painless and free from tenderness) is common on the inner aspect of the lower jaw, nearly opposite to the ends of the roots of the teeth. These exostoses are apt to be symmetrical on the two sides of the mouth, and occur over the sockets of sound teeth, with which they have, in fact, no relation; they rarely attain to such size as to cause material inconvenience.

Vascular Tumours, like small nævi, often occur between the necks of teeth; they bleed on the smallest touch, and are troublesome to extirpate, as from their situation it is often impossible to get beyond their bases without the sacrifice of sound teeth. Potassa fusa is the most efficient caustic for their destruction.

In *Mercurial Salivation* the gums are swollen and red, and in severe cases deeply ulcerated and sloughing. The treatment for this condition hardly falls within the scope of this article, but it is mentioned here because, especially in uncleanly mouths and in unhealthy subjects, effects somewhat similar have been observed where artificial teeth carried upon red vulcanite (which is coloured by vermilion) have been worn. At the instance of the late Dr. Bathurst Woodman, a committee of the Odontological Society collected a large mass of evidence upon this subject, with the result of failing to find the smallest valid evidence of this irritation having anything to do with the presence of mercury in the vulcanite ("Trans. Odont. Society," 1877).

ODONTALGIA.—The occurrence of pain, referred either to a tooth or to some remote part of the face or head, is that which generally brings the patient to seek relief, and the relief of this is all that will ordinarily be asked of the general Surgeon. It will be therefore convenient to group together the various conditions which may cause pain, and to give a few hints as to the readiest means of arriving at a diagnosis.

Often a mere inspection of the mouth, aided perhaps by a dentist's mirror, will reveal the nature of the evil; but leaving out of the question those cases in which the cause is obvious, I will take those only in which no cavities of any size are visible, or, if there are any, only such as are efficiently filled.

Pain that is paroxysmal, being severe at times and at others wholly absent, is generally due to a diseased but living tooth-pulp; pain that is constant, varying but little, to diseased tissues around a dead or dying tooth.

In making an examination, after carefully inspecting all the teeth, and searching them over with a finely pointed dentist's probe, tap gently each tooth in succession on the affected side; then press each firmly home into its socket, taking the pressure off suddenly; then press each from side to side; and, lastly, press with the soft part of the finger firmly over the roots of each tooth. If no painful sensation is elicited by these procedures, there is no inflammation of the alveolar periosteum, no impending alveolar abscess, and the cause of the pain is to be sought in a living tooth-pulp, or in an exostosis of the root (which *may* not give rise to tenderness under such examination).

But the existence of moderate tenderness does not absolutely prove the death of the nerve; it only points to its being diseased, probably dying, and this is the next point to ascertain.

Try each tooth with hot and cold water, if necessary isolating each one by means of the rubber dam, or with heated instruments of such bulk as to warm up the whole tooth. If the tooth is conscious of change of temperature, the nerve is alive; if it is hurt by it, the nerve is unhealthy; if a considerable degree of cold is grateful to it, the nerve is almost surely inflamed, and will die if it is not destroyed by applications for that purpose.

If the nerve be dead, the cause of pain will probably be the irritation set up by its decomposed remains escaping through the apical foramen, and the pulp-cavity must therefore be opened, its contents evacuated, and carbolic acid or creasote freely used.

But without proper instruments, specially devised for passing up into the root-canals, etc., the chances of success are small, and the tooth had better be extracted; even in the hands of a skilful dentist its preservation is not certain.

Sometimes, however, the mere opening up of the pulp-chamber, and the consequent removal of tension caused by pus or gas within it, will without further treatment relieve the pain.

Perhaps, on opening up the pulp-cavity, the nerve may be found to retain some vitality, although it was too nearly dead to respond to the application of heat or cold through the substance of the tooth. In such a case, a free application of creasote will allay pain almost at once.

If, however, the nerve be alive, the temporary aim of alleviating pain will be gained by the insertion, on a pledget of wool, of a little carbolic acid. The question of its ulterior treatment depends on its condition.

A nerve that is largely exposed, and has ached much, can rarely be restored to health, and the prospect is still less promising if it has begun to suppurate. In such cases the nerve must be destroyed before the tooth can be filled, and an arsenical application, made with due precautions (see page 317), had better be at once inserted.

It may not, for other reasons, be worth while to make any attempt to preserve the tooth, but it must not be forgotten that it is never necessary, merely for the cure of pain, to remove a tooth the nerve of which is alive.

It may be that careful examination has not revealed the existence of periosteal mischief, nor of an unhealthy tooth-pulp, and yet that the pain is really due to a tooth. Its roots may be exostosed, or they may be roughened and rendered irregular and pointed by absorption, and yet little tenderness be elicited on manipulating it. Or the pulp may be the seat of calcifications, or it may be in a state of irritation from the exposure of sensitive dentine at the neck of the tooth, the gum having receded from it. And in making your examination do not forget that you may have chanced upon the moment of death of the pulp, when the effects due to its decomposition are not yet set up, but all symptoms have for the moment disappeared, so that in a doubtful and difficult case the examination must be repeated twice or three. times at intervals of a day or two.

The difficulty of diagnosing the cause of pain, sometimes not slight, even when it is distinctly referred to the teeth, is tenfold more difficult when it takes the form of neuralgia elsewhere in the face or head.

Notwithstanding the opinion of the late Dr. Anstie and others that facial neuralgia is rarely due to the teeth, I am convinced that it is very often so caused, and that much needless suffering is allowed to continue owing to misapprehension on this subject. Because a neuralgia comes on after fatigue, is relieved or driven away by a meal, is benefited by a course of quinine or other tonics, and there is no local pain in any tooth, it is often at once concluded that its cause is elsewhere.

But, as a matter of fact, there is absolutely nothing in the way of symptoms which will serve to establish this conclusion; a neuralgia set up by teeth differs oftentimes in no respect from one set up by an undiscoverable cause, save only that, on adequate examination, dental mischief may be found.

Every case of facial neuralgia for which no other cause can be found should be submitted to an experienced eye for examination, because many of the conditions which commonly set it up are very liable to be overlooked.

Neuralgia is caused—(1.) By affections of the tooth-pulp. Most commonly by a localized patch of inflammation upon the pulp (see page 317); less often by general inflammation; by partial death and inflammation of the remainder; by irregular calcification of the tooth-pulp, a condition very difficult to diagnose; by irritation of the pulp through exposure of sensitive dentine, or approximation to it of large metallic fillings.

(2.) By affections of the surrounding parts. Periostitis of the alveolo-dentar periosteum, of a chronic form; exostosis of the root, and coincident periostitis, or consequent interference with the nerve fibrils entering the tooth, or even with the main nerve-trunk of the jaw; roughening of the roots by absorption; difficult eruption of teeth (almost always wisdom teeth).

Neuralgic pain due to teeth may affect any of the branches of the fifth nerve, and may extend to other nerves with which the fifth is connected.

The following sites, or foci, of pain are given as far as may be in the order of their frequency of occurrence:—the parietal region, the fellow-tooth of the other jaw, the supra-orbital notch, the infra-orbital foramen, the eyeball (the mischief would generally be found in an upper tooth), the ear and region of temporo-maxillary articulation, and the region of mental foramen, or the bicuspid tooth. In these last instances the lower wisdom tooth is most frequently the offender.

It is generally said that the severer forms of neuralgia are never due to dental irritation. This is generally, but not universally, true. I have seen a case due to an impacted wisdom tooth, in which most excruciating agony in the eyeball recurred at regular times, twice in the twenty-four hours. It was instantly cured by the removal, which was difficult, of the misplaced tooth.

The pain, in rarer instances, may be referred to the occipital nerve, or to the arm and shoulder.

Any or all of those secondary affections which occur in connection with neuralgia due to other causes, may occur when the neuralgia owes its origin to diseased teeth.

Thus, spasmodic contraction of the masseter is a common complication of difficult eruption of a lower wisdom tooth; wry-neck, strabismus, and ptosis are examples of muscular disturbances which have been unquestionably traced to dental irritation.

A very slight degree of paralysis of the arm and hand of the side affected, amounting to not much more than a sense of effort in using them, is not at all rare. Amaurosis has been clearly traced to this cause; and deafness during eruption of wisdom teeth is not very rare. Injection of the conjunctiva on the affected side is sometimes undoubtedly associated with dental neuralgia, and there is hence reason to believe it probable that deep-seated inflammation of the eye may be thus set up. Epileptiform convulsions are believed to have been traced to the irritation set up by teeth.

It may be noticed that almost all the diseased conditions to which teeth are liable have been enumerated as causes of neuralgia; under what circumstances the same apparent conditions cause local toothache, neuralgia, or no symptoms at all, we do not know. But the same tooth, with no apparent local change, may give rise to toothache one day, to neuralgia the next, and to nothing at all on the third; and looking to the great frequency of diseases of the teeth and to the comparative rarity of neuralgia, it is obvious that there must be some concurrence of influences not always present to produce this result.

The *Extraction of Teeth* may be called for in order to give space for the more orderly arrangement of the remaining teeth; because the tooth is misplaced and is a source of irritation; or because it is painful and does not admit of being restored to a healthy condition.

As a general rule it may be said that, provided there be enough left of it to make its preservation worth while, no tooth need be extracted as incurable unless its roots are materially altered by long-standing irritation. A first or a recent gumboil admits of tolerably certain cure, if only the roots of the tooth are fairly pervious.

The object to be attained is to remove the tooth with the smallest possible injury to its alveolus. In the case of many teeth with divergent or convergent fangs, injury is inevitable, the form of the part being such that the tooth could not be removed were not the socket either yielding or sufficiently fragile to break.

The alveolus becomes absorbed during the cicatrization which ensues, but if it is severely injured in extraction, or if it has been rendered unhealthy by prolonged inflammation, the healing process may be retarded by repeated exfoliation of small fragments from its edges.

To secure the best results, a large assortment of forceps is indispensable—not less certainly than fourteen or fifteen pairs—and many more are often advantageously employed, so that the instrument may exactly fit the tooth for which it is intended.

The blades of forceps must be very nicely tempered, so as not to be brittle, and yet to retain their edge, must come to a very thin, almost sharp edge, so as to readily pass between the tooth and the gum, and when grasping a tooth should exactly fit to its neck, so as to be in contact at every point.

The tooth should be very lightly grasped by the forceps, which are then firmly thrust up or down, as the case may be, so that the thin edges of their blades pass between the gum and the tooth, right down to and even a little within the edge of the alveolus. Then the grasp of the hand upon the handles is tightened, so that the blades may grip the neck of the tooth, which is then removed by that direction of movement most appropriate to the particular tooth.

Well-fitting forceps, when properly applied, should so grasp the tooth as not to admit of the slightest slip or motion between the two; they, in fact, should be tantamount to a simple elongation of the tooth, by means of which we can grasp it and exert a sufficient leverage to move it without calling for extreme effort.

Unless the crown of the tooth be of considerable strength, the handles of the forceps must not be gripped too tightly, lest, with the leverage gained by the shortness of the jaws as compared with the handles, the tooth be crushed. The handles should be kept in some degrees separated by the fleshy part of the thumb. The upper incisors and canines have roots approaching to regular cones, and may be most easily detached from their sockets by the use of slight rotation. No such rotation can be employed in the case of lower incisors and canines, which have roots flattened from side to side, and these must be removed by the alternation of inward and outward movements.

The outer alveolar plate being far more yielding than the inner, most teeth are removed by an outward motion, preceded by a slight inward motion, continued only till the tooth is found to yield slightly. But in the position of the lower wisdom tooth (and to some extent of the second lower molar), the inner alveolar plate is weaker than the outer, and therefore traction should be made chiefly towards it. In every case the operator should carefully bear in mind the direction and form of the roots of the tooth he is extracting, and should be prepared so to vary the movement of his hand as to follow the line of least resistance as he discovers it, and so to meet the difficulties interposed by any abnormal form of root. And if one side of the tooth be much more weakened by decay than the other, traction should, *cæteris paribus*, be made towards, rather than from, the weak side.

When a tooth is decayed quite down to or below the level of the gum, stump-forceps must be employed. These differ from others in the thinness and sharpness of their blades, adapting them to pass well within the margin of the alveolus. If the tooth have more than one root, one only should be attempted at a time; it is a safe and frequent practice to grasp one root (the strongest) of a lower molar with stump-forceps, in preference to grasping the whole with ordinary lower molar forceps, as in the event of only one root being thus extracted, the removal of the other will be easy, whereas a lower molar once broken in an unsuccessful attempt at its removal is an exceeding difficult tooth to extract.

Sometimes a tooth is decayed down to that stage when its removal entire is all but impossible, whilst the several roots yet cohere so strongly as to render their separate removal with stump-forceps very uncertain; this is especially apt to happen with upper molars. It becomes necessary to divide the roots, and this is best done by drilling, with the engine employed by dentists for many operations, a deep pit in the centre of the stump (a painless operation, such teeth being almost always dead); into this hole a spear-pointed elevator or the elevator blade of my own stump-forceps is introduced, and the tooth split. The removal of the individual roots will then be easy. The elevator is a very useful instrument for the extraction of lower wisdom teeth, and of many stumps; the most useful forms have blades terminating in small spear-points, or in a concave, sharp-edged blade, similar to one jaw of a pair of stump-forceps. The elevator is employed as a lever, making use of a neighbouring tooth as a fulcrum; it is a dangerous instrument in unskilful hands, but invaluable in skilled ones. It should always be so grasped that but a short length projects unguarded beyond the operator's thumb, and the left hand should be held so as at the same time to steady the jaw, and guard against the chances of a slip.

There are teeth which it is impossible to remove without undue violence and injury to surrounding parts, but such are seldom met with. Thus, sometimes, lower wisdom teeth are so impacted between the ascending ramus and the second molar that they cannot be safely removed, and the second molar may have to be sacrificed. But an elevator, in skilled and careful hands, will often prize out such a tooth even when it looks very unpromising.

When many teeth have been simultaneously removed, the breath is rendered fœtid and the patient caused much discomfort by the decomposing blood-clots in the mouth, and sometimes by ulceration of the wounded gums. The use of a disinfectant wash adds much to comfort and healthy action, and some such formula as this is both efficient and agreeable:—Acid carbolici, ʒj.; liq. potassæ, ʒj.; eau de Cologne, ℥ss.; aquæ, ad. ℥ss.; a teaspoonful to be added to a wine-glass of water.

The most frequent untoward accident resulting from the extraction of a tooth is persistent hæmorrhage. In this event the socket should be thoroughly cleaned from blood-clots, and well syringed with cold water; mild styptics should be applied, such as an ethereal solution of tannin, or dry tannin introduced on wool, and with this the socket carefully plugged till it is full, pressure being made upon it by a pad above it, on which the teeth are kept closed by means of a chin bandage. The most efficient material with which a socket can be plugged is matico leaf, softened in warm water; but this is a little difficult of application, and not always at hand. The object should be to stay the bleeding mainly by mechanical means, or by inducing the formation of a firm clot in the socket, rather than by powerful styptics such as perchloride of iron or nitrate of silver, which leave the mouth in a very sore and unhealthy state, besides incurring the danger, in a person of hæmorrhagic diathesis, of making fresh bleeding surfaces. Practically they need hardly ever be used.

Fracture of portions or of the whole thickness of the jaw were comparatively common in the days of the old key instrument, but even now occur occasionally, even in the hands of practitioners presumably skilful. They do not call for any special remark here, and may be treated on general principles.

The *Replacement of Lost Teeth* by artificial substitutes does not come within the scope of this article, although the aid of the dentist is often sought to fill up the gaps left by surgical operations, gunshot wounds, syphilitic necrosis, and the like, or to make an apparatus for fixing the fragments of a broken jaw.

For this latter purpose, the more cumbrous apparatus formerly in vogue has been, to a large extent, superseded by the simple wire-splint of Mr. Hammond, which, especially as improved by my friend and colleague, Mr. Moon, fulfils all the requirements of a splint, while subjecting the patient to a minimum of inconvenience. In principle it consists merely of two pieces of stout but soft wire—one fitted as accurately as time allows around the inner surface of the necks of the teeth, the other around the outer surface; the two being laced together by binding wires passing between the teeth, and twisted tight on the outer splint-wire.

There is, however, one class of cases in which it is often a matter of doubt whether a surgical operation or mechanical aid offers the preferable alternative, and very divergent opinions may be held upon the matter.

As a rule, Surgeons regard all cases of *cleft palate* as amenable to operation, and are apt to be satisfied with a surgical success which has effected but little improvement in voice and speech. Dentists, perhaps, go too far in the opposite direction. It is, of course, an enormous advantage to the patient to be independent of mechanical aids, which may get out of order at inconvenient times, and hence, *cæteris paribus*, operation is to be preferred. I have no experience of the result of closure of the hard palate by Dieffenbach's operation, as regards improvement in voice, but can hardly imagine any objection to its performance where the amount of palate existing offers any prospect of success, so that probably operative treatment is, in all favourable cases, preferable to the mechanical closure of the gap in the hard palate.

But there are a large number of cases of division of the soft palate which may be successfully united by operation without conferring upon the patient the advantage hoped for. When the soft parts are scanty, the velum formed by the operation is so tense, and has such slight range of motion, that it is unable to fairly close the road to the posterior nares, and the patient is comparatively little benefited. An artificial apparatus is better than a very tense velum; so far so, that in the practice of Dr. Kingsley, of New York, who has done very much for the improvement of these apparatus, a velum united by a thoroughly successful surgical operation was, with the knowledge and consent of the operating Surgeon, slit up again, and an artificial velum inserted with the best results. Indeed, one of the most eminent of American Surgeons, Dr. H. J. Bigelow, of Boston, told me that he now performed cleft-palate operations comparatively seldom, having been so pleased with the result attained by artificial substitutes as compared with vela formed by operation.

Artificial vela are made of a form of vulcanite which, after being fully vulcanized, remains soft and flexible; the material is perfect for the purpose, save only that it perishes after a time, so requires renewal, and that it is troublesome to manipulate. The soft and flexible portion of the apparatus is kept in place partly by its own accurate adaptation to the margins of the cleft, partly by being attached to a gold or vulcanite plate covering a part or all of the palate.

An accurate impression is first taken of the parts in plaster of Paris, which is the only material suited for the purpose, as it is put into the mouth in a condition sufficiently fluid to adapt itself to soft parts without displacing them. The taking of the plaster impression requires not a little dexterity and management, but a good model once secured, the remaining steps are comparatively easy.

A model in gutta-percha is made of the future soft, flexible portions of the apparatus; this is so made as to pass through the cleft, and to expand out both above and below its margin. It will thus hold up in place almost independently of the supporting palate-plate, except that it can slip backwards into the pharynx.

Having got a satisfactory dummy velum in gutta-percha, metal moulds are made from this, and in these the vulcanite one is vulcanized.

A well-made, well-adapted artificial velum is gripped by the muscular margin of the cleft, and moves freely with the soft parts, passing back to the back of the pharynx and efficiently cutting off the pharynx from the nares when required. The patient requires some little education before the voice loses its unpleasant tone in speaking, but the most satisfactory results are attainable. On the other hand, the apparatus is of necessity expensive; it require a vast deal of time and patience for its successful manufacture and adaptation, and the soft rubber wears out so that the vela require renewal.

To meet this objection, Dr. Suerson has adopted a simpler, but, in some cases, thoroughly efficacious plan; he carries back horizontally from the palate a rigid, immovable plate, extending nearly to the posterior wall of the pharynx, and finds that the muscular walls grip this sufficiently to answer most practical purposes. Personally, I have no experience of Dr. Suerson's obturators; they are able, however, to be made with less trouble, and therefore more cheaply, and do not wear out.

Gaps resultant upon surgical operation or upon syphilis require somewhat different treatment. The apparatus which closes them should not, as in congenital cleft palate, pass within the cleft, but should merely bridge it over; and this for two reasons—the one, that the edges of such cleft are lowly organized, irritable, and very liable to ulceration upon the smallest pressure; the other, that they tend to contract and close of themselves, and this process would of course be greatly hindered by an obturator impinging upon their margins.

CHAPTER XLVIII.

DISEASES OF THE JAWS.

INJURIES.—See FRACTURES and DISLOCATIONS.

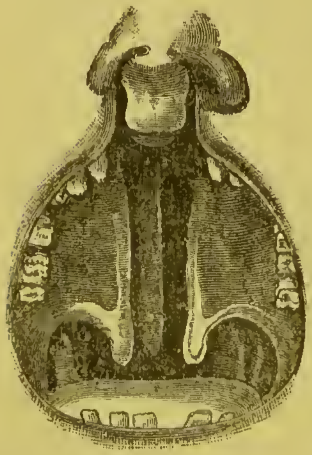
FISSURE OF THE PALATE, OR CLEFT PALATE.—This congenital malformation consists of a mesial fissure of the uvula alone, or of it and the soft palate; extending sometimes along the hard palate, and occasionally forwards to the upper lip, thus presenting the concomitant condition of single or double hare-lip. Rarely the lip and hard palate are fissured without involving the soft palate.

On opening the mouth the fissured condition is at once seen, and its obvious interference with speech and deglutition are readily elicited; the patient speaking with a snuffling, nasal tone of voice, and in the act of swallowing fluids some of the fluid regurgitates, and may escape through the nose.

The following description of this malformation, and of the operation, known as Staphyloraphy, for its curative treatment, is from the pen of my colleague, Mr. William Rose, who, as formerly the assistant to Sir William Fergusson, has had considerable experience with regard to cleft palate, and has himself operated in many cases with very successful results.

This condition is the result of an arrest of development occurring about the second or third month of fœtal life. At this period the superior maxillæ, with the exception of those portions of the bones which afterwards bear the incisor teeth, are developed separately from the first of the four series of visceral arches; but the central portion of the upper lip, together with those parts of the superior maxillæ just referred to, are developed from the median bud. This central and at present isolated portion is the seat of one, and some say two, ossific centres, and is known as the intermaxillary bone, or "os incisiorum," which about the eighth week begins to unite with the maxillæ proper. Should arrest of development take place before the coalescence of these lateral portions with the intermaxillary bone, a double hare-lip and cleft palate is the result. (See Fig. 693.) In well-marked cases of this deformity the maxillæ are widely separated from the intermaxillary bone, which in addition projects forward, forming a sort of nodule, covered by the central part of the upper lip, and is attached to and solely supported by the anterior inferior termination of the septum nasi. Although the treatment of hare-lip is entered into another part of this work, it may be well to draw attention to the slender support which in such cases this intermaxillary bone possesses; as this fact renders the stunted incisor teeth which afterwards appear in it

FIG. 693.*



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* After Mason.

quite useless for biting, and the patient's appearance unsightly from their forward projection.

This latter condition is obviated by the method adopted by some Surgeons of breaking the process backwards; but, as was pointed out by Sir William Fergusson, this generally resulted in the teeth growing horizontally instead of vertically, thus destroying their utility.

In the next less severe form of the deformity, the intermaxillary bone has united to one of the maxillæ and not to the other—it usually unites on the right side—and the cleft extends through the hard and soft palate, and then through the alveolar ridge and lip to the left of the median line, into the left nostril. This constitutes the usual form of single hare-lip and cleft palate. When arrest of development occurs after the formation of the alveolar arch—that is, after the tenth or eleventh week—the union of the hard and soft palate, which takes place from before backwards, may fail at any period, and thus are presented to the Surgeon varying degrees of cleft, from the bifid uvula to an entire cleft, reaching as far forward as the alveolar ridge. (See Figs. 694, 695.) The width, thickness of edge, and slope of the sides of the cleft are also extremely various, but should be carefully noted. In the worst cases there is scarcely any attempt at the formation of the palatal processes.

FIG. 694.*

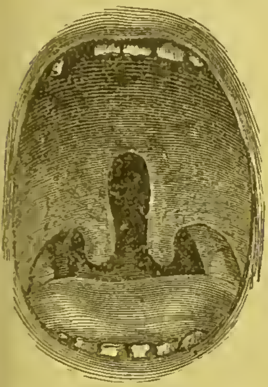
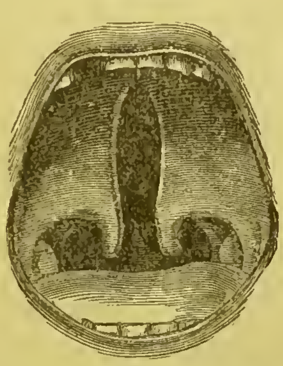


FIG. 695.*



It should also be borne in mind that the vomer covered by the nasal mucous membrane is often attached to one edge of the palate, usually the right, as this condition when present forms an element of difficulty in the performance of the operation of splitting the palate, recently suggested and successfully performed by the late Sir William Fergusson.

Age for Operation.—With the aid of chloroform and one of the many newly improved gags, the operation for closure of a cleft in the palate, involving either the soft parts only or both the hard and soft, may be performed at a much earlier period of life than formerly. Before the introduction of anæsthetics, the greatest courage and self-control on the part of the patient were necessary, in order to enable the Surgeon to perform this most difficult of surgical operations. Within the last few years, successful results have been obtained in children as young as three years (Billroth succeeded in one instance, the child being under twelve months, without chloroform), but it is not generally advisable to operate earlier than this; at the same time, there is no doubt that the earlier the operation be performed the less will be the impediment in the patient's speech.

Space does not allow of our entering into a detailed description of the various gags now in use. Suffice it to say that the simplest and most efficacious is an instrument (Fig. 696) a modification by Mr. Rose of the unilateral gag (Fig. 697) used by the late Sir W. Fergusson. The action of the palate muscles, particularly the levator palati, in drawing asunder the edges of the soft palate, has received considerable attention from various Surgeons, and thirty years ago Sir W. Fergusson first brought before the profession his method of dividing the muscles from behind with his triangular knife. Pollock, Sedillot, and other Surgeons have practised division of the palate muscles by making an incision in the soft palate of about an inch in length (see Fig. 699), parallel to the edge of the cleft, but Fergusson's plan possesses the advantage of being less likely to interfere with the vascular supply, besides being more scientific.

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* After Mason.

Fig. 696.*

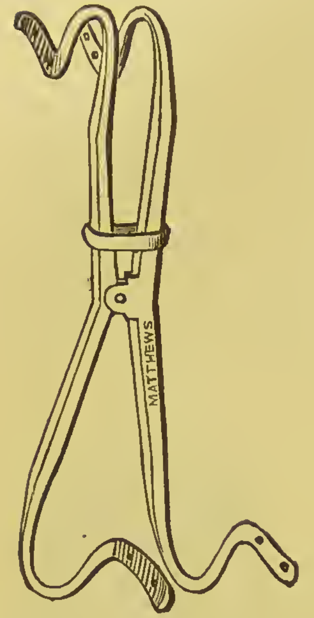
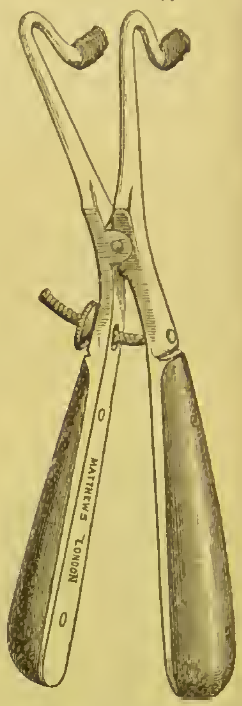
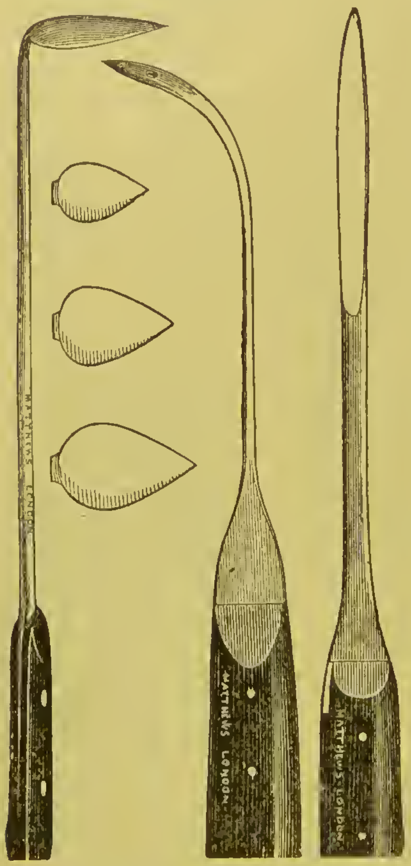


Fig. 697.



Operation.—The patient being placed upon a table in a good light, and chloroform having been administered, the mouth should be opened with the gag. The first step in the operation consists in passing the triangular knife (Fig. 698) behind the palate (Fig. 699), first on one side and then on the other, and pressing it outwards so as to divide the levator palati as it lies between the pterygoid plates. This often causes sharp hæmorrhage, and the pharynx should be kept clear of blood by being frequently swabbed with small sponges. Should the palato-glossus or palato-pharyngeus be seen to exercise any action on the sides, their fibres may be snipped with the scissors, the half uvula being drawn towards the median line with smooth forceps, in order to make the muscles tense.

Fig. 698.



The second step consists in paring the edges of the cleft with a fine narrow-bladed knife (see Fig. 698)—the merest shaving is sufficient—and the easiest way to effect this is to seize the one half of the uvula with a pair of fine hooked forceps, and, entering the point of the knife close to the forceps, with its back towards the tongue, cut upwards to the apex of the cleft. Repeating this on the other side, a continuous piece may frequently be removed.

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* The sliding ring passing up on either side of the hinge keeps the gag in position; the large end being used for adults, the other for children.

If the soft palate only be involved, the third and last step in the operation, that of passing the stitches and bringing the raw edges together, may now be effected. Wire, horsehair, and silk sutures have all been used with success, and have each their advocates; but fine silk thread, well waxed, is, on the whole, easiest of manipulation.

FIG. 699.

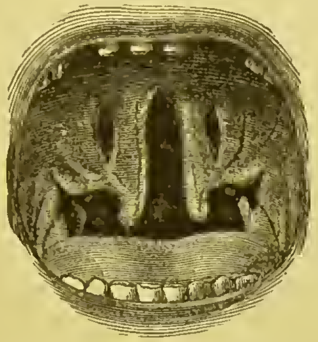
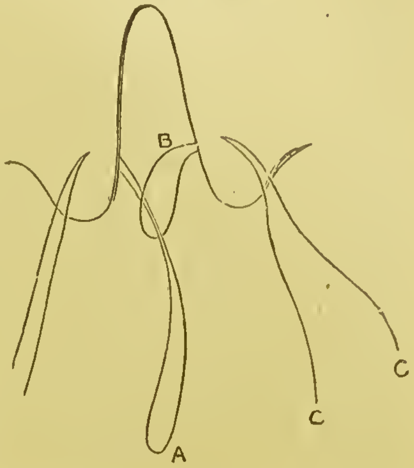


FIG. 700.*



The introduction of the sutures is best accomplished by the manœuvre attributed to Mr. Avory. A curved needle set in a handle, with an eye close to the point (see Fig. 698), and armed with a waxed thread of ordinary sized suture-silk, is passed from below upwards, about a quarter of an inch from the cut margin of the fissure; the thread is seized with forceps close to the eye of the needle, and drawn as a double thread out of the mouth, with the single ends also hanging out; when the needle is withdrawn, leaving the thread double through that edge of the palate. A similar double thread is then passed from below upwards, through the other margin, at the same distance from the cut surface and exactly opposite the first thread. Thus, there is now a double thread through each side of the fissure. (Fig. 700.) The left-hand loop, A, is next passed through the right, B, and on pulling the ends of the right thread, C C, the left is drawn through the right side. By holding one end and pulling on the loop, A, the thread will become single, and the ends may remain hanging out, one at either corner of the mouth ready, when the other stitches are passed, to be drawn tight and made fast. Two, three, or four threads are introduced in like manner, and then each is tied securely, first with a slip knot (Fig. 701), and then with a double reef. Care should be taken not to draw the threads too tight, lest the circulation in the edges of the flaps be interfered with

FIG. 701.

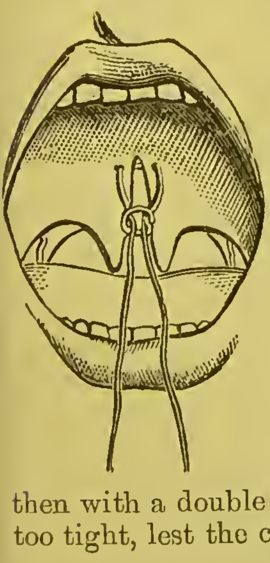
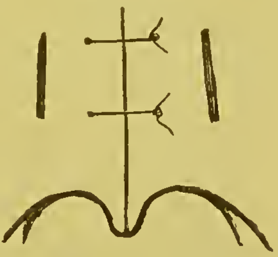


FIG. 702.



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* After Mason.

by pressure, as it should be borne in mind that a good deal of swelling generally follows, and, if the edges be drawn too closely together, their mutual pressure will hazard the occurrence of primary union. (Fig. 702.)

In cases where the cleft extends into the hard palate, it will be necessary, in addition to the steps already mentioned, to adopt one or other of the two methods about to be described, in order to bring the edges together. If the gap in the hard palate be not too wide or extensive, the whole cleft may be closed at one operation. The first method—introduced by Dr. Warren, of Boston, but known most generally as Langenbeck's operation—consists in separating the mucous and periosteal tissue from the bone, by entering a curved blunted instrument, called a raspatory (Fig. 703), through a short incision made down to the bone, close to the alveolar ridge on either side of the cleft. By carefully manœuvring the instrument, the soft tissues covering the hard palate may be so loosened as to be readily drawn to the median line with sutures. The bleeding is sometimes smart, and care should be taken not to wound the posterior palatine artery.

In very severe cases of cleft, and where the tissue covering the bone is extremely thin, this method frequently fails; and it was this failure that induced the late Sir William Fergusson, in 1873, to practise *osteotomy*, which in his skilful hands was attended with very successful results. It seems, however, that this operation was not novel, as Dieffenbach in 1845 suggested a somewhat similar plan, which, however, had but little trial, and still less success, on the continent.

FIG. 703.

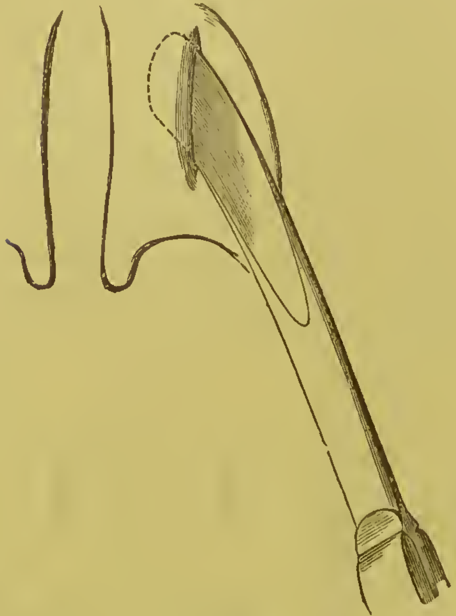
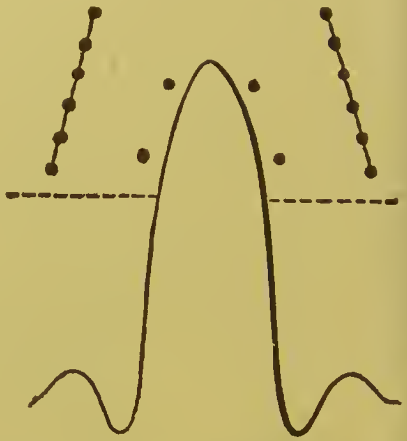


FIG. 704.



The following is a brief description of the operation of osteotomy, as performed by Sir William Fergusson. The edges of the cleft having been pared, and the palate muscles divided, one or two holes, according to the length of the fissure, are bored through the bone on either side, exactly opposite each other, with a small brad-awl, about one-eighth of an inch from the margin. (Fig. 704.) Through these holes threads (waxed silk is best) are passed, in the manner previously described, but are not drawn tight. A series of punctures through the bone is next made near the alveolar ridge (Fig. 704), parallel to the edge of the cleft. These perforations give a line, so to speak, to the chisel, which is now inserted and made to cut through the bone on either side. Mr. F. Mason, of St. Thomas's Hospital, claims to have suggested this preliminary use of the brad-awl, to prevent the chisel splintering the bone. It should be mentioned that if the vomer be attached to one edge of the cleft, it is extremely difficult to pass the stitches, and impossible, without detaching the vomer, to bring that edge of the palate on to a lower horizontal plane, which it is of great importance to effect, in order to lessen the height of the vault of the mouth, so essential to the ultimate improvement in speech. In such cases, therefore, it is advisable to strip the soft tissues off the bone on that side, as just described. By slightly twisting the handle of the chisel, the palatal process of the maxilla is broken from its anterior connections, and when this is repeated on the opposite side, the edges of the cleft in the hard palate can be approximated. The use of the chisel causes considerable hæmorrhage, which, however, can readily be staunched by plugging the lateral apertures with lint. Threads should now be passed, ready for tying, through the edges of the soft palate down to the apex of the uvula, and those lying loose in the holes bored in the hard palate having now been drawn tight, all the stitches should be fastened off in the usual way.

A purgative, such as a full dose of castor oil, may be given with advantage about the third day after the operation, to get rid of the clotted blood which may have been swallowed during this procedure.

It is usual to remove the stitches on the fourth day, and it is often a nice question to decide, in a doubtful case, whether to leave them in a little longer, or to take them out for fear of their causing harmful irritation. The plugs of lint should be removed on the second or third day. It is very important that the patient should be in a good state of general health at the time of the operation,—more especially free from cold, as any increase in the secretion in the nares tends to ooze through between the edges and prevent primary union.

For the first week after the operation. the patient must not speak, should be kept perfectly quiet in bed (if able to write should be provided with a slate and pencil), with the head low, so that any mucus forming may drain back into the pharynx. A fluid diet should be ordered, consisting of milk, beef-tea, eggs beaten up, and plain soups taken cold, for the first twenty-four hours.

The improvement in the speech is generally slow, but much may be done by practice; the patient being taught to open the mouth wide, and to endeavour to pronounce each letter distinctly, with the nostrils kept closed between the fingers.

There is a great deal to be said in favour of both the methods just described of closing the hard palate. Langenbeck's operation seems to be more applicable to the less severe forms of cleft in the hard palate, while Sir William's operation can be performed in cases where the former could not be adopted, *i.e.*, when the soft tissues covering the bone are extremely thin, and the cleft very wide.

During the three last years of Sir William's life, he used the chisel in more than eighty cases, most of which were successful, and many of them cases in which no operation had previously been considered possible. In three instances necrosis of the detached portion of the palate process occurred, and the result was necessarily unsatisfactory;

but it should be remembered that in Langenbeck's operation, sloughing of the soft parts is, in severe cases, not rare.

In perforations of the hard or soft palate, caused generally by syphilitic ulceration, no operation for their closure can with any confidence be recommended, for the loss of tissue is so decided, and the patient's general constitution so depraved, that primary union can hardly be looked for. In these cases an *obturator* of vulcanite or india-rubber, to close the aperture and render the speech more distinct, is all that can be done.

Mechanical Treatment.—As a substitute for any operative procedure to effect the closure of Cleft Palate, an *artificial palate* may, perhaps, be constructed, and worn with much advantage. Mr. A. Nasmyth brought forward this mode of treatment in 1845, and Mr. C. H. Stearns, at the same time, in America. The palate or obturator is made of various materials,—a gold or ivory plate, caoutchouc, etc. Mr. Sercombe has brought this resource to such perfection, in its adaptation to very extensive clefts, as to render an operation more a matter of choice than of necessity, for the improvement of the voice and performance of deglutition. Obviously, no obturator should be worn continuously, which can obstruct the development of the jaw in childhood, or cause absorption of the natural bone, and thereby enlarge the fissure.

Diseases of the Jaws.—*Necrosis.*—The Jaws are subject to Necrosis from at least three causes: Syphilis, Exanthematous poison, especially that of scarlet fever, and Phosphorus. The latter form of Necrosis occurs among those whose occupation exposes them to the fumes of phosphorus, as in the making of lucifer matches. Dr. Wilks, among British writers, appears to have first drawn attention to this source of necrosis,—in the Guy's Hospital Reports of 1846–47. In Germany, phosphorus-necrosis was recognized as early as 1839, by Lorinser, who published a paper upon the subject in 1845, and was followed by other authors.

The mode in which the necrosis is produced, seems to be by the entrance of phosphorus-fumes into the osseous structure of the jaws, through carious teeth or an open socket; the disease never arising when the teeth of the workmen are sound. The liability of the two jaws to this necrosis appears to be about equal, or with a slight preponderance against the lower jaw. Of 52 cases given by German authorities, 21 were of the upper jaw, 25 of the lower jaw; in 5 both jaws were affected, and 1 case is uncertain. The English statistics gathered by Mr. Salter point to nearly the same conclusions. Excellent specimens of the disease, as affecting both jaws, are to be found in the Museum of St. Bartholomew's Hospital.

Symptoms.—The same symptoms arise, whatever be the cause of Necrosis; but in that proceeding from phosphorus, they are most marked. Toothache, intermittent at first, becomes continuous; the teeth loosen, and pus exudes from the sockets. The gums are swollen and tender, and detached more or less from the alveoli. Swelling of the face takes place, to perhaps a considerable extent, so that if only one side of the jaw is affected, a peculiar lop-sided appearance results; one or more fistulous openings also discharge pus, and lead down to bare and dead bone. The general health yields under the constant suffering, loss of food, and the poisonous influence of purulent matter swallowed daily.

Terminations.—Death may, at length, take place from exhaustion, or rapidly from gangrene of the cheeks and lips; recovery occasionally ensues, with considerable loss of bone and deformity. The repair, after necrosis of the jaw, is sometimes very complete, the formation of new bone being very prolific. A pumice-stone deposit of bone on the sequestrum is almost constant, and has been regarded as characteristic of phosphorus-necrosis. It is derived from the periosteum, and though resembling true bone, it is decidedly of lower development. This deposit is not found in the disease of the upper jaw. It would seem also not to be peculiar to phosphorus-necrosis, the pumice-like bone sometimes encrusting a sequestrum which has resulted apparently from rheumatic periostitis; as shown by Mr. Perry's case in the "Medico-Chirurgical Transactions," vol. xxi. In a remarkable case recorded by Mr. Thomas Smith, in the St. Bartholomew's Hospital Reports of 1865, phosphorus-necrosis of the entire lower jaw was followed by restoration of the jaw. The new bone appears to be produced either from the periosteum, or from the surrounding soft parts when the periosteal membrane has lost its vitality; and, in Mr. Smith's case, the reparation thence derived was sufficient to reproduce the jaw. In that case also, two other notable points were illustrated; the reparative material was formed, not around, but entirely in front of or below the sequestrum, and there was an absence of pumice-stone deposit. The former condition existed in the lower jaw of a patient, some years since, at the Royal Free Hospital; and from whom Mr. T. Wakley removed the sequestrum, which extended nearly from angle to angle of the jaw. I assisted in the operation, and particularly noted the form of reparation. Repair of the lower jaw seems to be but temporary; the new bone diminishing by absorption to a mere arch, and ultimately being scarcely sufficient to keep out the lower lip, the chin is quite lost. It is a question how far this loss by absorption might be prevented by supplying the new jaw with a function through the means of artificial teeth.

Treatment.—The cause of necrosis must, of course, be removed; any exposure to the influence of phosphorus would perpetuate that form of disease. Any decayed teeth or stumps should therefore be extracted, as the source of local irritation. Detergent gargles of chlorinated soda or permanganate of potash may be advantageously used to cleanse the mouth. Opium, to allay pain, with tonics and whatever nutritious food can be taken to support the strength, are the only measures available, pending the detachment of the sequestrum, and the production of an enveloping shell of new bone adequate to maintain the form of the jaw. The sequestrum is then to be extracted through the mouth, if possible, or through incisions placed so as to leave the least subsequent deformity. The permanent set of teeth should be preserved, when practicable. "Subperiosteal resection" has been much advocated by foreign Surgeons; as M. Rizzoli, Flourens, Maissonneuve, and Ollier of Lyons. This operation does not apparantly differ from the extraction of sequestra, as ordinarily practised.

Prevention in the case of phosphorus-necrosis has been ably investigated by Dr. Bristow, in Mr. Simon's Report to the Privy Council, 1863. Working with *amorphous* phosphorus is unattended with danger, for the disease arises exclusively from the fumes of common phosphorus.

UPPER JAW.—*Abscess of the Antrum.*—In connection with Dental Surgery, abscess of the antrum has been specially considered; but in the diagnosis and treatment of tumours of the upper jaw, the general Surgeon must take notice of the kind of swelling presented by a purulent collection within the antrum. Arising from the irritation of carious teeth, which may be in immediate relation to the antrum, or unconnected with that cavity, as the incisor teeth, the disease commences as alveolar abscess, which bursts, directly or indirectly, into the antrum. But abscess of the antrum may result from catarrhal or other inflammation of the lining membrane; or it may be of traumatic origin,—the extraction of a tooth communicating with the cavity, the entrance of a foreign body, a blow on the cheek, or injury received during birth in a pubic presentation. An instance of the latter occasion of injury, having induced abscess of the antrum in an infant a fortnight old, is recorded by Dr. G. A. Rees, in the *Medical Gazette* (N. S.), vol. iv.

The *symptoms* are, at first, those simply of inflammation of the lining membrane: dull, deep-seated pain shooting up the face and to the forehead, swelling and tenderness of the cheek, with considerable fever and constitutional disturbance. A slight rigor sometimes announces the formation of matter, which may find its way into the nostril, when the patient is lying on his sound side, either through the normal opening, or an opening resulting from absorption, as maintained by M. Giraldès. Generally the pus, not finding a ready exit, distends the antrum; bulging out the cheek, uplifting the floor of the orbit, depressing the hard palate, and, loosening the teeth, obstructing the nasal duct and closing the nostril. The wall of the cavity undergoes absorption, and becoming thinned, it yields a peculiar parchment-like crackling under pressure with the finger. The matter may burst externally, into the mouth or into the nostril; in either case considerable necrosis and scar will probably be the result.

Treatment.—Any carious teeth or stumps must be extracted. This may be followed by a flow of pus, when the introduction of a trocar through the alveolus will completely evacuate the matter. When all the teeth are apparently sound, the first molar tooth should be extracted, as having the deepest socket and being most liable to decay, and then the socket must be punctured.

Puncturing the Antrum.—Care should be taken in using the trocar, lest it penetrate with a jerk and injure the orbital plate. The alveolus admits of being punctured above the gum, and this will be necessary in the rare case of suppuration occurring in old people, after loss of the teeth. The cavity should then be cleansed by syringing with warm water, by means of a curved canula and hydrocele elastic bottle. A slightly astringent injection may be advisable; and a weak solution of permanganate of potash or sulphate of zinc answers admirably. The entrance of any particles of food should be prevented, by plugging the aperture with cotton-wool; or, as Mr. Salter has suggested, by fitting a metal plate to the mouth, with a small tube to fill the aperture, which can be corked at pleasure and serves as a pipe for injection. In puncturing the antrum, the possible subdivision of this cavity, owing to the existence of bony septa, will be an obviously important condition; and especially with reference to the extraction of a foreign body, as the fang of a tooth lodging in one of these subdivisions.

Chronic abscess of the antrum, producing a slow expansion of this cavity, may be mistaken for a solid growth, as Liston has seen happen; and particularly when there is considerable hypertrophy of the osseous wall in consequence of prolonged irritation, a condition which Stanley mentions as having occurred in the practice of Sir W. Lawrence.

Dropsy of the Antrum.—The symptoms are the same as those of abscess, only that the enlargement is painless, and more slowly produced. The fluid evacuated is a clear or yellowish serous fluid, and frequently contains flakes of cholesterine. This condition was formerly attributed to obstruction of the aperture between the antrum and nostril; thus allowing a gradual accumulation of the mucous secretion. It is now regarded as the production of a cyst or cysts within the antrum, or in connection with the fangs of the teeth,—dentigerous cysts, which either grow to such a size as to be mistaken for the cavity of the antrum when opened, or burst into the antrum, leaving no trace of cyst-formation. Hence the character of the contained fluid, serous and not mucous.

The swelling of the cheek may subside, the jaw resuming its original size; and, the discharge from a punctured alveolus having ceased, the aperture closes. Collapse of the antrum sometimes results; with perhaps absorption of the front wall, causing a projection of the upper wall, in the form of a prominent horizontal ridge of bone immediately below the orbit. This remarkable deformity was found in the person of an old woman, a subject in the dissecting-room at King's College; and it was originally described by Sir W. Fergusson as probably a unique specimen.

Dropsy, like abscess, of the antrum may be mistaken for a solid growth; and in one case a very able Surgeon removed the upper jaw before discovering the error of his diagnosis. An exploratory puncture will determine the question; as was shown in a very remarkable case of simulation which occurred in the practice of Sir W. Fergusson, and is recorded in the *Medical Times*, 1850.

Puncture of the antrum and evacuation of the fluid is the only mode of cure; and this proved successful in the case last cited.

TUMOURS.—*Hyperostosis*, or simple osseous hypertrophy, and various morbid growths or tumours are liable to form in, or in connection with, the Jaws, as in other parts. Thus, *fibro-cellular*, *fibrous* and *recurring fibroid*, *cystic*, *cartilaginous*, *osseous* and *myeloid*, *vascular*, or erectile, and *cancerous* tumours have severally been met with.

The pathology of all these morbid growths differs in no essential particulars from that of the same growths in other situations.

Their *diagnosis* demands some special notice. The differential characters of these tumours are, however, not well marked, and their diagnosis, therefore, is by no means unequivocal; but this difficulty is practically unimportant, excepting with reference to the distinction of cancerous or malignant and non-malignant forms of maxillary growths.

In examining any tumour of the *Upper Jaw*, a careful inspection and palpation, as far as possible, should be made of the face, mouth, and nares. In making a rhinoscopic examination, the nares should be illuminated by the Laryngoscope. A small mirror is placed at the back of the throat, at such an angle that luminous rays falling on it are reflected into the nares, whilst the image formed in the mirror is seen by the observer. An antral tumour can thus be clearly distinguished from a polypus springing from the turbinate bones, or a growth springing from the base of the skull. The condition of the hard and soft palate should be examined with the finger, and behind the soft palate to ascertain any extension of the growth in that direction. The consistency of the projection beneath the teeth is more readily discovered, and the finger should be passed over it both outside and inside the cheek.

Non-malignant growths are more or less hard to the touch, and painless. They grow slowly, and have no tendency to involve surrounding parts or the skin, except by mechanical interference; the general health also remains unaffected. Myeloid and vascular tumours are softer than other non-malignant growths, and more vascular in appearance where they are covered only by mucous membrane. They grow more rapidly, occasionally ulcerate, but do not fungate, as in fibrous tumours of the upper jaw, and may then bleed profusely. *Encephaloid cancer* is characterized by its softness, and gnawing pain affecting the face and head; its rapid growth, and tendency to fungate and bleed.

Tumours of the *Lower Jaw* are more open to diagnosis. *Non-malignant* growths are distinguished by hardness, and slowness of growth, with no tendency to fungate within the mouth, and no enlargement of the neighbouring lymphatic glands. After a time, the unchecked growth may burst through the skin and present a fungating mass; but this has a more healthy appearance and is of slower growth than the encephaloid fungus. *Cancerous* tumours generally originate within the bone, and grow rapidly; tumours having these characters are almost invariably cancerous.

Treatment.—*Medicinal* treatment with the view of inducing absorption can be of little avail. A small enchondroma of the upper jaw is said to have been thus removed, under the care of Mr. Stanley, by the application of iodine.

Early and complete *excision* of the growth is the only cure; in non-malignant tumours, before the anatomical relations of the growth have become too complicated to admit of complete extirpation; in cancerous tumours, before the surrounding structures have become involved.

The results of such operations are more successful in respect to tumours of the lower jaw, as the whole disease can be more completely removed. What security there may be in the removal of half the jaw affected with cancer, is still an open question.

Excision of the Upper Jaw.—This operation was first performed by Mr. Syme.* Of several methods of operation, that which is most generally applicable is as follows:—The patient sitting, or lying recumbent and under the influence of chloroform, the central incisor tooth of the diseased jaw is extracted, and two incisions are then made. First, a bistoury is entered at the junction of the malar and upper maxillary bones, and carried down with a curvilinear incision into the angle of the mouth. Secondly, another incision is made from the nasal process of the upper maxilla down along the side of the nose, round the ala, which it detaches, and perpendicularly through the centre of the upper lip into the mouth. The flap, thus defined, is dissected up to the margin of the orbit, and its contents—the eyeball and its surroundings—cautiously raised from the floor of this cavity, protected by a curved retractor held by an assistant standing behind over the head of the patient. The bones are then divided by strong cutting-pliers; the junction of the malar bone first, then the nasal process, one blade of the pliers being inserted into the orbit—the eye still protected, and the other into the nose; and lastly, the alveolus is notched with a narrow-bladed saw, where the incisor tooth was extracted, and the palatine arch divided by passing strong, sharp-cutting pliers—one blade into the mouth and the other into the floor of the nose. Weiss's "eccentric-jointed" pliers is the form of instrument (Fig. 705) which works with the greatest facility. The palatine process of the palate-bone with the velum palati, or soft palate, should be left untouched, if possible. The osseous mass, thus detached from its connections, is drawn downwards and forwards, and easily removed. Ligatures must be applied to the facial and transverse facial arteries, or any other vessels which cannot be secured by torsion or pressure. The large cavity exposed is plugged with lint from the bottom, the flap of integument replaced over it, and retained in position by a few twisted sutures in the cheek and upper lip. No portion of integument should be pared off, however redundant it may at first appear; having been stretched over the osseous tumour, it will contract and pucker up. The ultimate disfigurement resulting from this operation is comparatively inconspicuous.

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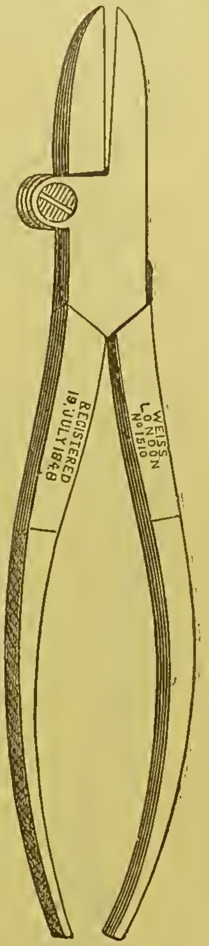
* "Edin. Med. Journal," 1868, p. 558.

FIG. 705.



The *malar bone* may be involved in the disease, with the whole of the superior maxilla; then the zygoma and junction of the malar with the external angular process of the frontal bone, must each be divided externally with the pliers, and the operation completed as for removal of the superior maxilla alone.

The *malar bone* and the *orbital plate of the superior maxilla*, forming the floor of the orbit, may be sound; then, a groove having been made with a small saw, across from the nasal process of the maxillary to the outer margin of the malar bone, the separation is completed with the forceps, including the remainder of the bone as above described.

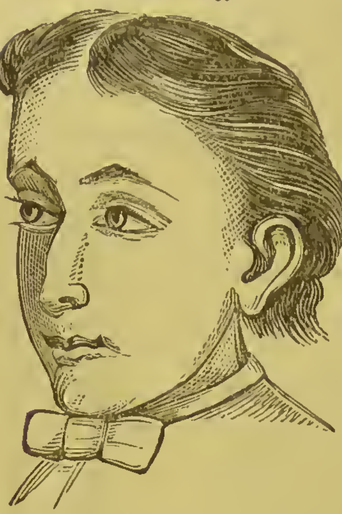
Modifications of this Operation have been practised with success by Sir W. Fergusson.

(*a.*) A transverse incision, slightly curved, may be made from the junction of the malar bone below the eye, across to the nasal process, instead of curving downwards into the angle of the mouth. Considerable hæmorrhage will thus be avoided, and the other incision may be made as already indicated.

(*b.*) A single incision from the angle of the mouth upwards and outwards, has enabled him to remove tumours of some size; or an incision through the centre of the upper lip to the base of the columna and into the nostril, has afforded sufficient space for the removal of tumours of such size as it would be deemed advisable to operate on.

By the latter incision, I have excised nearly the whole of the antrum, with the alveolar border of the jaw, enclosing a cystic growth, which projected forward on the cheek and downwards under the upper lip. The result was successful; the line of incision being scarcely visible, nor any disfigurement of the face (Fig. 706), and the patient could eat readily and speak distinctly.

FIG. 706.*

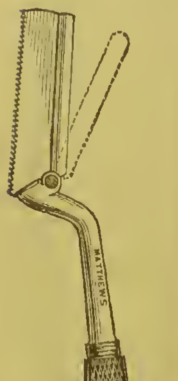


EXCISION OF THE LOWER JAW.—*Partial* removal of this bone will generally suffice—the disease being situated on one side, and between the symphysis and angle of the jaw, or involving the ramus, or extending beyond the symphysis to the other side.

Complete removal of the jaw, by disarticulation at the temporo-maxillary articulation, on either side, is rarely rendered necessary by the extent of the disease.

The plan of any such operation, partial or entire, is the same. The object is, to remove the diseased bone, with the most facility and least ultimate deformity. An incision under the chin, along the body of the bone and ramus, answers both purposes.

FIG. 707.



(1.) Partial excision—say, of one-half of the jaw—is performed as follows:—The point of a scalpel should be entered behind the articulation, and an incision carried down the posterior border of the ramus behind the angle, thence along under the body of the bone to the chin, and curving upwards, it terminates about an inch from the margin of the lip. In the course of this incision, the facial artery will be divided, but the coronary is avoided. The former is at once ligatured. The flap is dissected up, thoroughly exposing the tumour, the knife passed under it into the cavity of the mouth and along the jaw, keeping close to the bone, and thus detaching the mucous membrane. The central incisor tooth of the diseased side having been extracted in commencing the operation, the jaw should here be sawn through with a small, narrow-bladed saw, having a movable back—as devised by Mr. John Wood (Fig. 707); or, having been fairly notched, it may be clipped through with the cutting-pliers by a firm and snapping grip. Laying hold of the tumour with one hand, and moderately depressing the body of the bone, the Surgeon severs the attachment of the temporal muscle to the coronoid process by a light touch with the knife; then, the masseter muscle having been already detached in raising the integument, the articulation is entered from the front, and by carrying the knife round the condyle, with its edge closely turned towards the neck of this process to avoid wounding the internal maxillary artery, the pterygoid muscles are divided, and the excision completed. Should the internal maxillary require ligature, the common trunk of this vessel and the temporal artery—the termination of the external carotid—will be found as it emerges from under the border of the posterior belly of the digastric muscle. The cavity is filled with lint, the flap replaced, and neatly retained with twisted sutures.

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* Royal Free Hospital. (Author.)

A *more partial* excision of the lower jaw, between the symphysis and angle, can be effected in like manner; the incision under the body of the bone extending only between these two points, and the cutting-pliers being applied posteriorly at the angle, as well as at the symphysis.

Beyond the symphysis, the operation may be extended by continuing the incision, and applying the saw and forceps at the limit of the disease, on either side. Whenever the operation extends beyond the symphysis, necessitating a division of the muscles on either side, which pass from the jaw to the tongue, this organ must be secured and drawn forwards by means of a ligature previously introduced through the tongue, and thus held by an assistant. Otherwise, the tongue, loosened anteriorly, may be retracted into the pharynx—swallowed, in fact, and threaten, or actually occasion, suffocation.

In a *unique* case, *both lateral* portions of the jaw were removed, leaving only a small portion of the symphysis. A non-malignant tumour on the right side having been excised, with that portion of the jaw, by Mr. Fergusson in 1836, a similar tumour on the left side, with that portion of the jaw, was removed by Mr. Spence, after an interval of six years—in 1842. The patient, a woman, aged forty-six at the date of the first operation, made a good recovery after the second operation. She lived for fourteen years, and could chew with the front teeth so as to eat animal food. Post-mortem examination showed that the space on either side of the symphysis was occupied by a very dense structure, giving attachment to the masseter and internal pterygoid muscles.

(2.) The *entire* jaw can be removed *en masse*, by an incision carried round, and a disarticulation corresponding to that for the removal of half the bone.

During the process of healing by granulation, the patient must be fed with liquid food, spooned into the mouth or sucked through a tube. A dense fibrous tissue gradually forms a kind of substitute jaw; and, especially when the articulations are left untouched, the movements and appearance of the lower part of the face are far more perfect than might be expected. It has often occurred to me that some kind of artificial supplementary jaw, with teeth, might be fixed upon the fibrous matrix, and, when an appropriate opportunity offers, I shall endeavour to put this notion into practice. My earliest recollections of these operations on the jaws date back to their memorable performance by Mr. Liston, at the University College Hospital; and, although upwards of thirty years have elapsed since first I witnessed such an operation, the scene—ere the days of chloroform or ether—of the master operator, with his massive hand, snapping through the jaw-bone of the patient seated before him, the group of assistants, and the multitude of students in the theatre—lives in my memory with the freshness of yesterday.

CLOSURE OF THE JAWS.—This condition implies more or less inability to open the mouth and to perform the act of mastication. It may be spasmodic or permanent.

(1.) *Spasmodic* closure, sometimes of several weeks' duration, is almost invariably connected with difficult eruption of the wisdom teeth of the lower jaw. Owing to want of space for, or malposition of, the tooth, constant pressure thus occasioned, induces a state of tonic spasm of the masseter and internal pterygoid muscles.

The *treatment* consists in opening the mouth under the influence of chloroform, and with the aid of wedges or a screw gag; the second molar must then be extracted to make room for the wisdom tooth, or the tooth itself may bo removed.

(2.) *Permanent* closure may be the result of several causes operating mechanically;—profuse salivation, with sloughing of the cheeks and the formation of rigid cicatrices which draw up and hold the lower jaw closely and tightly against the upper; anchylosis of the temporo-maxillary articulations, in consequence of injury, or of arthritic inflammation; the formation of an osseous bridge between the jaws, or the lower jaw and temporal bone, as a rare consequence of chronic articular arthritis; pressure of a neighbouring tumour, especially in the parotid region, so as to directly fix the joint. Besides interfering with mastication and articulation, permanent closure in early life is often followed by stunted development of the jaw, presenting a marked shortening of the chin and an oblique direction of the front teeth. With perforation of the cheek, there is a constant dribbling escape of the saliva, and the most disgusting disfigurement.

Treatment must have reference to the nature and situation of the cause of closure.

Rigid cicatrices may be relieved, not perhaps permanently remedied, by excision of the contracted integument; the patient wearing for months or years the silver shields adapted to the upper and lower jaws by Mr. Clendon, or other suitable apparatus, to counteract the tendency to re-contraction. Anchylosis of the temporo-maxillary articulations may be overcome by mechanically breaking up the adhesions, under the influence of chloroform. An osseous bridge, connecting the jaws, can be severed and removed by cutting-pliers and a small saw; but this proceeding must be warranted by an accurate diagnosis. Any tumour which mechanically impedes the motion of the jaw may be extirpated, provided its anatomical relations to the parotid gland do not contra-indicate such operation.

The formation of an *artificial joint* in the lower jaw was originally suggested by Esmarch in 1855; followed by Rizzoli in 1857, who quite independently conceived a similar idea. The one, however, performed excision of the joint; the other simply cut through the jaw, without removing any portion of bone.

Esmarch's operation appears to be preferable, as facilitating the formation of a false, movable joint. It was first performed by Dr. Wilms, of Berlin, in 1858, and successfully; shortly afterwards by Esmarch, with equal success; and subsequently by Diltt, of Vienna, and by Wagner, of Königsberg. It was introduced into this country by Mr. Mitchell Henry, the patient sinking from pyæmia; since which some satisfactory results have been obtained. A small incision along the edge of the jaw exposes the articulation, when sufficient bone should be removed to give free motion—say, half an inch—by means of a Hey's saw or chain-saw.

Rizzoli's operation has proved successful in his own hands, in four cases, and it has been performed also by Professor Esterle. No external incision is made, but section of the jaw—not excision—is accomplished from the interior of the mouth, with powerful forceps. Both these operations have proved unsuccessful, owing to reunion of the divided jaw.

THE NECK.

CHAPTER XLIX.

INJURIES OF LARYNX AND TRACHEA, PHARYNX AND ŒSOPHAGUS.

Larynx and Trachea.—No department of Surgery demands greater promptitude of action on the part of the practitioner than that which relates to the larynx and trachea; so that, being thrown on his own resources, ready knowledge is here more especially requisite.

Injuries of the Larynx sometimes occur, in the form of compression or fracture of the laryngeal cartilages; the former lesion mostly in young persons, when the cartilages are soft and yielding; the latter injury more often in persons of advanced age, when these structures have undergone some degree of ossification. At the middle period of life, adults are less liable to either injury, as the cartilages are then self-protected both by their elasticity and resistant strength. Compression or fracture of the larynx is attended with more or less contusion or bruising, affecting the soft parts around the seat of injury, and also the sub-cellular tissue of the laryngeal mucous membrance.

These laryngeal injuries are produced by some mode of direct violence; as in strangulation or garotting; or from a powerful blow or fall on the box of the larynx.

The danger of laryngeal compression or fracture is that of suffocation; but in the one case, there will be less risk of immediate asphyxia, unless the pressure be prolonged; for the laryngeal cartilages recover their natural shape and position, as soon as the cause is removed. Asphyxia may supervene in consequence of either form of injury; owing to extravasation of blood in the laryngeal mucous tissue, or from inflammatory effusion therein as œdema glottidis, or simply as a spasmodic affection induced by irritation.

Treatment must have immediate recourse to the measures appropriate for the prevention or removal of these contingencies, interstitial hæmorrhage, inflammation, and spasm. Hence the application of leeches to the throat, cold lotions or warm fomentations, with some general lowering treatment and anti-spasmodics. In the event of impending suffocation, tracheotomy must be performed.

Wounds of the Throat.—These injuries are inflicted commonly with suicidal intent, and usually therefore with a cutting instrument, as a razor or knife; forming the wound ordinarily known as cut throat. This wound is a transverse and upturned incision, somewhat jagged or lacerated, and varying in depth and extent.

It may be a *superficial* wound, dividing only the integument, and to a limited extent, in front of the throat; or extend across the throat, from side to side, or ear to ear, and sever the carotid vessels—artery and vein, with perhaps the pneumogastric nerve—on one or both sides, and if sufficiently low down in the neck, the phrenic nerve may be touched. An integumental wound, commencing on one side of the throat, may divide these vascular and nerve-trunks on that side; but a wound sufficiently resolute to extend to the other side—cutting the throat, as it is popularly termed, from ear to ear—and dividing the vessels on both sides, will scarcely be effected without involving deeper parts.

A *deep* wound involves the air-passages, and perhaps the pharynx or œsophagus. The appearance and functional phenomena differ somewhat according to the situation of the wound. It may be *above* the *hyoid* bone; thus opening the mouth under the tongue, which perchance will be touched, and the power of deglutition is lost. Or, the wound may pass across the *thyro-hyoid space*, above the larynx, the commonest situation; opening the *pharynx*, and perhaps shaving off the epiglottis or touching the glottis itself, and here also deglutition is incomplete. Or, the *larynx* may be divided anteriorly, exhibiting a transverse gap, through which the air issues during each expiration, with a rushing, bubbling sound, and with almost sufficient force to blow out a candle if held near the aperture. The voice is lost or reduced to a broken whisper, but it is restored on closing this opening in the windpipe. Similar phenomena are observed when the *trachea* is opened. The *thyroid body* will be almost necessarily involved, an important source of hæmorrhage. The *œsophagus* can be opened only by a deeper wound, passing through the trachea. But, in rare instances, both windpipe and gullet have been divided down to, and implicating, the *vertebral column* beneath. The windpipe is usually cut in front and high up, the suicide imagining that a wound of the air-passage is mortal; and thus the prominence of the larynx mostly invites the attempt. Hence also, the great vessels and nerves, on either side of the throat, providentially escape injury.

Consequences and prognosis.—*Hæmorrhage* is the immediate source of danger. It may be venous; proceeding from the plexus in front of the trachea, or from the internal jugular vein. The carotid trunk or its branches are the source of arterial hæmorrhage; and the trunk must be wounded if the jugular vein be implicated. Death may speedily ensue, directly from hæmorrhage, or from the blood trickling into the windpipe, producing asphyxia, or inflammation of the lungs at a later period. Occasionally death arises from the accidental sucking up of air into the veins, inducing asphyxia. Division of a large nerve, the pneumogastric or phrenic, occurs usually in conjunction with wound of the larger vessels; and division of the phrenic on one side only may be almost immediately fatal, either by partially suspending respiration, or in consequence of inflammatory congestion of the lungs. *Asphyxia*, in connection with or as a consequence of cut throat, may arise, as already stated, from hæmorrhage into the trachea, or from lesion of the phrenic nerve, or congestive pneumonia consequent on either state; but pneumonia or bronchitis is liable to result also from the introduction of cold air into the lungs through the wound, by inflammation extending downwards from the aperture in the windpipe. *Œdema of the glottis* in consequence of inflammation, or the irritation or impaction of a partly detached epiglottis, may severally induce asphyxia, when the wound is above the larynx. Loss of the natural sensibility of the glottis, preventing its efficient closure, will allow food to pass into the larynx and through the external wound, without any wound of the pharynx or œsophagus. Mucus also is apt to accumulate in the bronchi, owing to their diminished sensibility. *Lastly*, the respiration may be mechanically impeded below the epiglottis; either by a partly detached portion of cartilage hanging into a laryngeal or tracheal wound, or by overlapping of the lower portion of the trachea by the upper portion, when this tube is completely divided.

Treatment.—The general indications are—to arrest hæmorrhage, to adjust the wound for reparation, to obviate any difficulty of respiration, to administer food, and to avert inflammation of the trachea or lungs.

(1.) *Hæmorrhage* must be arrested by the ligature of any bleeding vessel, whether artery or vein, so as to prevent any oozing or trickling into the larynx or trachea. The introduction of a silver tube into the windpipe aperture of the wound will obviate the liability of blood being sucked in by each act of inspiration. This should be withdrawn as soon as oozing hæmorrhage has ceased. (2.) The *wound* should be adjusted by position, rather than by sutures. An *integumental* wound may be advantageously united by a few points of suture, throughout its extent. In a *deeper* wound, involving the windpipe, partial union only can take place, owing to the mobility of the parts subject to the actions of respiration and deglutition; the wound closes chiefly by granulation and cicatrization. If primary union happen to occur in the central part of the wound, coagula are apt to accumulate beneath, threatening suffocation by pressure upon, or passing into, the windpipe, and the wound will have to be reopened for their removal. The extremities, or integumental portion of the incision, may be retained together by a suture or two, leaving the central portion open; the head should then be brought forwards, so as to depress the chin towards the sternum, and fixed in position by a bandage round the crown, with a lateral strip passing down on either side of the face, fastened to a band around the chest. If the trachea be completely divided, a suture or two should be inserted into each side of the *tube*, to retain its ends together. (3.) Difficulty of *breathing* must be prevented or overcome, by having regard to the circumstances already enumerated which give rise to dyspnœa. The temperature of the apartment should be maintained at about 80° Fahrenheit; and the air moistened and softened, as it is breathed through the windpipe aperture, by covering the wound with a piece of muslin loosely folded, beneath which a clean sponge moistened with warm water may be placed adjoining the air aperture. This aperture must be carefully kept open and free of any clot, or other occasion of impediment to the breathing. A wound above the larynx, and followed by œdema of the glottis, will necessitate recourse to tracheotomy. (4.) The administration of *food* becomes a difficulty only when the pharynx or œsophagus is opened. Food is best introduced by means of a large-sized elastic catheter, or the tube of the stomach-pump, passed through the mouth into the gullet below the opening. If this mode of feeding cause great irritation, nutritive enemata may be resorted to. The food is necessarily liquid, but strong beef-tea, soup, or Liebig's *liquor carnis*, milk, eggs beat up with brandy or wine, can be thus administered, and the patient's life indefinitely prolonged, until he is able to swallow without assistance.

(5.) *Inflammation*, in the form of bronchitis, will probably be averted by due attention, as already directed, to the temperature of the atmosphere which the patient breathes through the windpipe aperture; and pneumonia prevented by watchful observation, more especially with regard to any trickling hæmorrhage into this aperture. In the event of either form of inflammation, the treatment accordingly must be conducted on ordinary principles; taking, however, into consideration the state of the patient, as reduced by hæmorrhage and his depressed mental condition.

The wound, in the course of granulation, requires nothing more than water-dressing, or other simple applications.

Aërial Fistula sometimes ensues; the skin having doubled in and become adherent to the edge of the aperture in the air-tube, a jet of air passes and repasses through, with each act of respiration. This happens most frequently in the thyro-hyoid space. Mr. Erichsen has found the following operation successful in closing such a fistula:—The edges of the opening are to be freely pared, and the knife passed under them for some distance to detach them from the subjacent parts, a vertical incision also being made through the lower lip of the opening, splitting it downwards. Two points of suture are then inserted into each side of the horizontal incisions, bringing their edges into contact; but the vertical cut is left free for discharges and mucus to drain away, and for the expired air to escape, lest emphysema occur. Unless this outlet be left, the sutures will burst, and union of the edges be frustrated. An aërial fistula cannot be safely closed when the larynx above is obstructed, and it may even become necessary to enlarge the opening and introduce a silver tube to compensate for the laryngeal obstruction.

A *Stab* in the Throat, involving the trachea, presents no peculiarity from an ordinary cut throat; except the liability to emphysema, by escape of air into the surrounding cellular texture, if the wound be narrow and slanting. Compression, with a pad of lint, well retained by strips of plaster, will generally succeed in overcoming this difficulty.

Foreign Bodies in the Air-passages—*Larynx*, *Trachea*, or *Bronchi*. —Various substances that admit of being swallowed, occasionally pass into the rima glottidis, and thence, perhaps, lower down into the air-passage; any such body is, however, not swallowed into the glottis, in an effort of deglutition, but *inhaled* into this opening from the mouth, by a sudden inspiration, in the act of laughing or talking with the substance in the mouth. It is drawn by the current of air between the dilated lips of the glottis. Various substances may thus pass the "wrong way"—a bit of meat, a cherry-stone, a bean, pea, nut-shell, or a tooth, money, a button, a bullet, pill, or pebble, a pin, fish-bone, or piece of stick.

The *Symptoms* are those of suddenly obstructed respiration, and of irritation, followed by those of inflammation. But the symptoms vary in intensity according to the situation of the foreign body.

Impacted in the *rima glottidis*, any substance so placed completely obstructs respiration, and the individual, suddenly turning blue in the face, drops down dead almost instantaneously. Not uncommonly a violent explosive cough or two ejects the foreign body, and the peril is over, although spasmodic coughing still remains for a time, owing to the irritation. In the *larynx*, the foreign body may lodge or hitch in one of the ventricles, or slip down into the *trachea;* the same spasmodic coughing is evoked, with great difficulty of breathing and sense of suffocation, and pain referred to the episternal notch, a croupy sound is heard through the stethoscope, during respiration, but the voice is broken or lost. All these symptoms are most intense when the larynx is the seat of impaction. In the trachea, the foreign body has more room, and the urgent symptoms subside perhaps for a while; or, the foreign substance moving up and down occasionally, particularly if the patient move, coughing returns with increased violence, and the body can be heard and even felt to strike the larynx, seeming to threaten instant suffocation. In the *bronchi*, a foreign body is comparatively tolerated; the respiration is more or less embarrassed, and a whistling or murmuring sound may be heard over the seat of lodgment; sometimes also, during coughing, the body is dislodged and driven upwards. The right bronchus is generally that into which the foreign body falls, it being larger, though passing outwards almost transversely; while the left bronchus, of smaller size, inclines obliquely downwards and outwards, more directly in the line of the trachea. According to Professor Spence's observations, the foreign body has always been found in the left bronchus.

The *diagnosis* from laryngitis or croup turns mainly on the history of the dyspnœa; the apparent introduction of a foreign body in the act of eating and laughing, for example, and the sudden origin of the symptoms from that occasion, constitute the chief points of distinction.

Consequences.—Inflammation of the larynx, trachea, bronchi, or lungs, supervenes in a variable period, but generally in a few days after the more urgent symptoms of dyspnœa have subsided. Cough, pain, and muco-purulent, perhaps bloody, expectoration succeed; and they continue until the patient is worn down, in a few months or a year or two, and dies from hectic exhaustion. Rarely, the foreign body may be coughed up again; in one instance, Heckster relates that a ducat was thus ejected after two years and a half imprisonment; in another case, Tulpius states that a nut-shell was coughed up after a lodgment of seven years—the patients in both cases recovering. Sometimes death ensues, although the body has been ejected; as in an instance given by Sue, in which a pigeon-bone was spat up seventeen years after its introduction, the patient dying about a year afterwards from marasmus.

The *prognosis* depends on the size and physical character of the foreign body, and the period of its incarceration. Mr. Erichsen finds that, after the immediate danger, the greatest risk occurs between the second day and the end of the first month, no fewer than eleven patients out of twenty-one having died during this period; but that the mortality diminished until the third month, when it increased again. The cause of death also varies according to the period of the fatal result. During the first twenty-four or forty-eight hours, it happens from convulsions and sudden asphyxia; during the first few weeks, it is apt to occur from inflammation of the lungs; and after some months have elapsed, death results from hectic exhaustion.

Treatment.—The obvious indication is to get the foreign body out of the windpipe; but the proceeding to be taken should be guided by the urgency of dyspnœa. (1.) Impaction in the *rima glottidis* will demand—when opportunity offers—immediate search below the root of the tongue with the finger, and extrication of the substance from the chink of the larynx. Failing to accomplish its removal, laryngotomy must be performed immediately, and a probe passed through the laryngeal aperture into the larynx to dislodge the foreign body. (2.) Lodgment within the *larynx*, or *trachea*, may allow of some delay; in order to quiet spasm of the laryngeal muscles, which prevents the ejection of a body, not itself too large to be coughed up. With this view, it may be desirable to bring the patient somewhat under the inflence of narcotics or chloroform. Inversion of the body—by holding the patient with his heels upwards and head downwards, shaking the body at the same time, or slapping the back—will probably cause the substance to drop out of the air-passage and escape through the mouth. A child can be readily held, head downwards; but for a grown person some mechanical contrivance may be necessary, such as was used in the case of the eminent engineer, Mr. Brunel, when he accidentally swallowed a half-sovereign. If suffocation threaten, the attempt must be abandoned.

Laryngotomy or *tracheotomy* should be resorted to without delay, in the event of the foreign body still remaining in the windpipe. The respiration is thus set free, and the irritability of the laryngeal muscles subsides; so that the substance may be expelled through the larynx, or more probably through the artificial aperture. Sometimes, it can be safely extracted, or made to drop out by inversion. The temporary absence of symptoms, such as convulsive cough, impending suffocation, or of any sound or movement as of the foreign body, might mislead the Surgeon as to the imperative necessity for operating; but this treacherous quiescence will not justify the postponement of tracheotomy. Otherwise, the danger returning suddenly, even after the lapse of some days, the patient may die asphyxiated before surgical assistance can be obtained. Some such admonitory cases have occurred. Chloroform should not be administered when the foreign body, lying loose in the trachea, may possibly be ejected through the aperture, by an expulsive effort; but when the body is impacted, it must be extracted, and then the introduction of an instrument will be much facilitated by the state of anæsthesia.

The *results* of cases, as left to nature or subjected to treatment, are well shown by the statistical facts collected by Professor Gross, respecting 159 cases of foreign bodies in the air-passages. Spontaneous expulsion occurred in 57, 8 terminating fatally. Inversion of the body alone was successful in 5 cases, and unsuccessful in 6. In 68 cases, tracheotomy was performed; 60 lived and 8 died. In 17, laryngotomy was practised; 13 lived and 4 died. In 13, laryngo-tracheotomy was performed; and of these, 10 recovered and 3 died. It thus appears that of the 98 cases in which the windpipe was opened, for the removal of foreign bodies, 83 were successful, and 15 fatal,—or the deaths were in the proportion of 1 to $5\frac{1}{2}$. Of the three kinds of operation, tracheotomy was most favourable, the deaths being only in the ratio of 1 to $8\frac{1}{2}$; whereas, after each of the other two operations, the proportion of deaths was twice as great. The most frequent cause of death was inflammation of the lungs.

Scalds of the Glottis, Mouth, and Pharynx—not unfrequently happen among the children of the poor, in their attempting to drink from the spout of a kettle containing boiling water. The act of swallowing is not complete, but the inside of the mouth and pharynx are scalded, and *œdema* of the glottis is speedily induced; the interior of the larynx remaining unaffected. A similar state may be produced by the inhalation of flame in the explosion of gas or fire-damp.

The *symptoms* are, immediate and urgent suffocative cough, and difficulty of breathing; and the appearances are, puffed and turgid lips, the interior of the mouth and fauces having a whitened and soddened aspect. Death soon follows, unless the inflammation be subdued.

Treatment.—Leeches to the throat, and small, repeated doses of calomel and opium, may succeed in reducing the œdema; but the urgency of the dyspnœa will probably necessitate tracheotomy without delay, as the only chance of safety; and a tube must be introduced into the tracheal aperture and retained there, until this has subsided under the continuance of remedial measures. The operation is rendered more than usually difficult, by the shortness, fatness, and turgidity of the neck, and small size of the trachea. Having performed the operation several times, under these circumstances, I can confirm the opinion of those Surgeons who regard it as only an unavoidable alternative between death and the possible preservation of life, and that the result is generally fatal, from the supervention of bronchitis or pneumonia.

Strong mineral *acids* are occasionally swallowed, either with suicidal intent or by accident. The effects of such fluids, as sulphuric acid, are similar to those produced by boiling water, the mucous membrance of the fauces and pharynx becoming whitened and corrugated, with some tendency to œdema glottidis. But, in Mr. Spence's experience of such cases, suffocation is rarely so urgent as to necessitate recourse to tracheotomy.

Asphyxia or Apnœa.—These terms are synonymous only by usage, as being understood to signify want of breath; their etymological meaning is widely different—the one signifying an absence of pulse (ἀ, not, σφύζω, I beat); the other, an absence of breath (ἀ, not, πνέω, I breathe). Apnœa should, therefore, correctly speaking, be the term selected to designate the various forms of suspended or impeded respiration; but the term Asphyxia has, by association, become so familiar that I here employ it as having that meaning.

Symptoms.—Dyspnœa or difficulty of breathing, as indicated by the respiratory movements; which, at first short and rapid, soon become deep, forcible, and prolonged, with a gradually widening interval between them, until just before they entirely cease, when they again diminish in force and duration. The circulation of blood undergoes concurrent changes; the heart's action, at first accelerated, in a few seconds becomes slow, laboured, and feeble, till the pulse ceases to be perceptible at the wrist. The heart, however, still beats, audibly to the ear, and palpably to the hand, applied to the chest; this action gradually becomes less and less distinct, till it entirely stops at a period within ten minutes after the first interruption to the respiration. The period that elapses between the last respiratory effort and the cessation of the heart's action, varies from two to four minutes. Cerebral symptoms accompany the circulatory changes, and in somewhat the following order:—a sensation of fulness in the head, and giddiness, singing in the ears, and flashes of light dancing before the eyes; then follow pleasing, almost voluptuous dreams, which soon fade away into insensibility and unconsciousness, speedily succeeded by convulsions. The *appearances* of the person undergoing asphyxia are peculiar; an extremely anxious expression of countenance, blueness of the lips, starting of the eyeballs, distension of the vessels of the face, head, and neck, frothy mucus, occasionally sanguineous, about the mouth, involuntary passage of the fæces and urine, and sometimes an emission of semen with or without erection.

All the symptoms are modified and proceed more or less rapidly, according to the cause of asphyxia.

Port-Mortem Appearances.—The *external* appearances depend on the period after death,—in the course of twelve hours, any characteristic appearances will mostly have passed off; and they are modified by the cause of fatal asphyxia. At an *early* period,—within three or four hours after death,—lividity of the lips, with oozing froth, and perhaps slightly sanguineous mucus, are conspicuous; lividity and swelling of the tongue, which presents impressions of the teeth upon its margin, may also be observable; the eyelids are half open, and the pupils dilated; but the countenance is generally placid and pallid, or faintly livid. These appearances, however, resemble the facial aspect of death from epilepsy; or they may, in part, proceed from heart-disease, concussion of the brain, and perhaps other causes of death. Rigor mortis sets in early, and particularly after *drowning* in ice-cold water. The hands are clenched, sometimes so firmly in the drowned as to be opened only by great force, even to cause fracture of the finger-bones. Death resulting from asphyxia mechanically induced, usually leaves some marks of violence, such as ecchymosis or laceration at the seat of injury. There may be the mark of a cord upon the neck after *hanging*, or of fingers on the neck after throttling; the hyoid bone also is sometimes fractured, or the cartilages of the larynx are dislocated. The *internal* appearances consist chiefly of venous congestion of certain organs, with a proportionally anæmic condition of other organs. The heart and great vessels are greatly engorged with black blood, on the right side; the left side of the organ is generally empty, or contains venous blood as on the right side. The blood throughout the body has a venous tint, and is sometimes found in a fluid state. The portal system is much engorged, involving, therefore, the liver and spleen. The kidneys partake of the general venous congestion. The lungs are not so entirely nor invariably congested as has been asserted in most works; and the brain—according to the results of experiments on animals, by Ackermann—is always in an anæmic condition; the cerebral vessels becoming congested merely as the mechanical result of the post-mortem distribution of the blood, in consequence of a dependent position of the head. Extravasations of blood within the cranium occasionally result from injury to the head in the mode of death.

Death by *drowning* is distinguished by one peculiarity in the state of the air-passages and lungs; these organs contain water, or other foreign matter, as mud, duckweed, etc.; there being no exclusion of foreign matter by spasm of the glottis, as was formerly supposed. This admission of foreign matter is established by the observations of the Committee of Inquiry appointed by the Royal Medico-Chirurgical Society, and whose report appeared in the "Transactions," 1862.

The *causes* of asphyxia may be arranged under four general heads: (1) A mechanical impediment to the entrance of air into the lungs; (2) drowning; (3) the absence of oxygen in the respired gas; (4) inhalation of a toxic vapour, associated with an absence of oxygen. The following tabulated view, by Dr. George Harley, presents at a glance a very useful enumeration of the particular causes of asphyxia, comprised under each of these general modes of causation.

Asphyxia may arise from—

1st. Mechanical Impediment to the Entrance of Air into the Lungs.	Accident.	External.	Pressure on the trunk preventing the expansion of the chest; throttling; garotting; strangulation by a cord; hanging; smothering, by covering the mouth and nostrils, imbedding the face in earth, feathers, wool, etc.; paralysis of the respiratory muscles from injury to the spinal cord, or to the base of the brain; double penetrating wound of the chest, admitting air.
		Internal.	Choking from a morsel of food or other substance blocking up the fauces; plugging of the trachea by a cherry-stone or other substance; constriction of the fauces and injury to the glottis from application of corrosive and irritating fluids.
	Disease.	External.	Pressure on the trachea from an aneurism or other tumour.
		Internal.	Œdema of the glottis; tumour on or about the vocal cords; false membrane blocking up the air-passages, as in diphtheria or croup; bursting of an abscess or aneurism into the trachea; double pneumonia or pleurisy; accumulation of mucus in the bronchial tubes; apoplexy at the base of the brain or in the medulla oblongata, causing paralysis of the pneumogastric, and of the respiratory muscles.
2nd. Drowning			In any liquid of whatever nature—water, wine, beer, or brine.
3rd. Absence of Oxygen in the respired gases.			Inhalation of pure nitrogen, hydrogen, or any other innocuous gas.
4th. Inhalation of a toxic gas or vapour.	In which death is erroneously attributed to Asphyxia.		Carbonic acid, carbonic oxide, coal-gas, choke-damp, ammonia, chlorine, sulphuretted hydrogen, arseniuretted hydrogen, antimonuretted hydrogen, sulphurous acid, nitrous acid, hydrocyanic acid, vapour of chloroform, ether, amylene, or any other volatile product.

Treatment.—The primary indication is to arterialize or oxygenate the blood as soon as possible; this implying the restoration of respiration, and circulation—by certain resources—any adverse condition having been previously removed.

Artificial Respiration.—This may be effected by various apparatus-less means, and which, therefore, are always applicable.

(1.) By simultaneous pressure on the abdomen and thorax, alternated with relaxation, twenty or thirty times *per* minute. The compression should be made over the lower part of the sternum and upper and middle part of the abdomen, so as to partially expel the air from the thorax, without allowing any counteractive effect by descent of the diaphragm; the resilience of the thoracic walls enables the air to rush into the lungs, and then compression is repeated. If food be forced up from the stomach, the patient should be placed on his face for a few seconds, while any such matter is expelled, lest it pass into the windpipe.

(2.) *Marshall Hall's method*—or the "ready method"—consists in laying the patient on his face, with the right arm bent under his forehead; being so held by an assistant, to prevent any obstruction to the mouth, which should be seen to be open, and cleared out of any dirt or mucus. Then, the operator, standing over the back and grasping the left shoulder and hip, turns the body half-way backwards, and then forwards again on to the face; thus to and fro, pausing in each position for about two seconds, so as to make about fifteen such complete movements per minute. This method has been largely practised, and has proved very successful in restoring respiration. Yet its efficacy was not so favourably reported by the Committee of the Royal Medico-Chirurgical Society, the whole amount of exchange of air sometimes not exceeding a few cubic inches, and never exceeding fifteen cubic inches.

(3.) *Silvester's method*—or the "physiological method"—consists in the imitation of the natural action, as during deep inspiration, of the pectoral and other muscles passing from the shoulders to the walls of the chest. Inspiration is imitated by slowly extending the arms upwards by the sides of the head until the elbows nearly touch each other; expiration is then performed by simply restoring the arms to the sides of the chest, and pressing them against it, or pressure on the lower part of the sternum will have the same effect and more readily than lateral pressure with the arms. This method seems superior to Marshall Hall's in two important elements: the *first* step in the restoration of breathing is a movement of expansion to a chest already in a state of expiration; and *both* sides of the chest are left uncompressed and free to expand. The quantity of air thus exchanged often exceeds thirty cubic inches, and in one instance amounted to fifty cubic inches.

The *circulation.*—Restoration of this function is partly effected by that of respiration—by arterialization of the blood and the respiratory movements. But certain special means of stimulation should also be resorted to; such are warm frictions all over the body, and more especially of the limbs; warm coffee or tea, and brandy, when the patient can swallow, should be administered, or previously by the stomach-pump, and stimulant enemata; a warm bath, not above 106° Fahr., will also be requisite, when the temperature of the body is much reduced, as by drowning in the winter season. Artificial respiration by pressure can be readily applied while the body is in the bath.

As soon as the natural respiratory movements recommence, artificial respiration may be discontinued, or renewed only to aid the efforts when feeble and imperfect.

Treatment after Natural Respiration.—The following directions are appended by Dr. Harley:—(1.) Give the patient some warm nutriment, to which a small quantity of stimulant is added; beef-tea, chicken-soup, coffee, or tea with one or two tablespoonfuls of brandy. (2.) Put him into a well-aired bed, with hot bottles to his feet, and encourage sleep. (3.) Let him be carefully watched during sleep in case of secondary apnœa; at the slightest symptom of which let gentle frictions and, if necessary, artificial respiration be again had recourse to. Give volatile stimulants, such as the spiritus ammoniæ aromaticus, or sp. ætheris nitrici.

In the case of the *drowned*, the following might be said to be the four golden rules of treatment:—(1.) Empty the air-passages of all the water and frothy mucus they may chance to contain, by holding the legs and trunk higher than the head. (2.) Wipe the mouth and nostrils dry. (3.) Draw forward the tongue. (4.) Use artificial respiration.

PHARYNX and ŒSOPHAGUS.—*Wounds* of the gullet occur, most frequently, in connection with cut throat, as a complication of this form of injury.

Foreign Bodies.—Various substances are liable to become impacted in the pharynx or œsophagus; some of which obstruct the passage by their size, as a lump of meat; others impinging, by their pointed shape, as a fish-bone, or owing to their irregular form, as a set of artificial teeth, which, in more than one case, has been dislodged into the gullet. The former substances stick either in the pharynx, about opposite the larynx, where the tube is narrowed at the commencement of the œsophagus; or, low down towards the cardiac orifice of the stomach.

The *symptoms* are those of choking and suffocative cough, with turgidity and blueness of the face; and the foreign body can probably be felt on introducing the finger into the pharynx. If unremoved, asphyxia may soon prove fatal. Low down in the œsophagus a similar obstruction produces equal difficulty in the passage of anything swallowed, though not any difficulty in the act of deglutition itself, and a sense of oppression with pain about the top of the sternum; but the degree of actual suffocation will depend on the pressure of the impacted body on the trachea. The substance can be detected by the introduction of an oiled probang, carefully passed down to the seat of obstruction.

Small pointed bodies commonly lodge in some fold of mucous membrane, behind the root of the tongue, between it and the epiglottis, or in the sides of the pharynx. Any substance so placed is felt by the individual, more particularly in the act of swallowing; and it may, perhaps, be seen, or felt with the finger.

Complications and *Consequences.*—Rupture of the gullet has been produced, either by the violence of impaction, or in consequence of ulceration with the formation of abscess in the cellular texture around the tube. Fatal hæmorrhage also has ensued. In a remarkable case, at the University College Hospital, many years since, a street-juggler passed, as usual, a long, round-ended sword down his throat; when he suddenly sprang into the air and fell in a state of collapse. In this state I saw him, on being brought to the Hospital; a loose emphysematous crackling could be distinctly heard, and even felt, under the sternum in the anterior mediastinum, during each hurried respiration. The poor fellow soon died, when it was found that the sword had obliquely perforated the œsophagus and pericardium at the base of the heart. As assistant curator of the Museum at that time, it became my duty to make a preparation of this interesting specimen, which, with the sword placed by its side in a long glass jar, is preserved in the Museum.

Treatment.—The foreign body impacted, must either be extracted or pushed down into the stomach; but which of these two proceedings may be proper will depend on the situation and nature of the substance.

In the *pharynx*, any kind of foreign body should be extracted, if possible. The patient being seated, with his head thrown back and mouth wide open, the Surgeon introduces his forefinger straight into the pharynx, and searching for the substance, hooks it up with his finger, or by a hook-probang, or removes it with curved forceps guided by the finger. A pointed foreign body, as a fish-bone or a pin, must be withdrawn very carefully, lest it lacerate the pharynx. When any such body has been removed, a pricking sensation will still be experienced by the patient for a while. A digestible substance, as a lump of meat, might be pushed down, through the œsophagus, into the stomach, by means of a sponge-headed probang with spring-expanding shaft, A B. (Fig. 708.) Low down in the *œsophagus*, an impacted foreign body may commonly be pushed into the stomach in like manner; or, perchance, by directing the patient to swallow a large mouthful of bread. But a rough substance, which would thus rupture the œsophagus, or one of a metallic or other kind unsuited to the stomach, as a half-crown, had better be drawn up gradually by the hook-probang (Fig. 709) or by forceps. Sometimes, an emetic will succeed in dislodging and ejecting the substance; or it has been dissolved, as in the case of a chicken-bone, by swallowing large quantities of dilute acid. This, however, is obviously an objectionable proceeding.

FIG. 708.

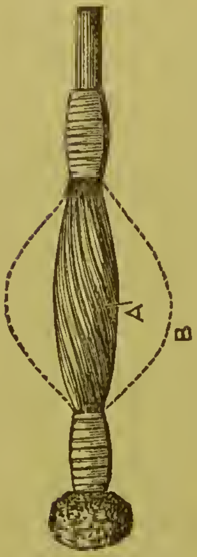
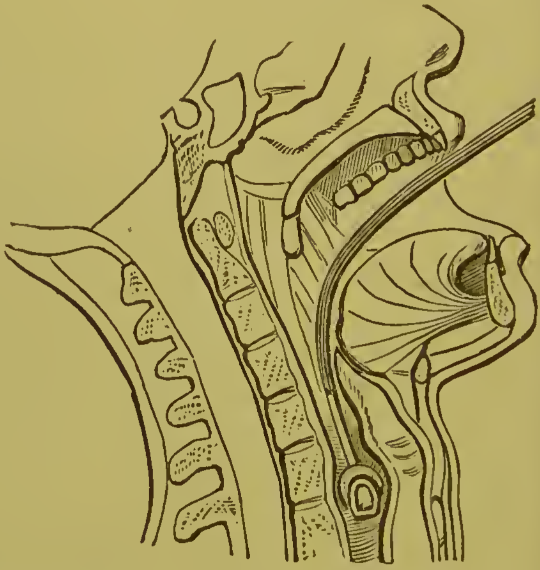


FIG. 709.



All other means having failed, *pharyngotomy* or *œsophagotomy* must be resorted to for the extraction of the impacted substance.

Asphyxia may be so urgent that it will be absolutely necessary to perform *tracheotomy*, before attempting to remove the foreign body from the œsophagus. Generally, however, the attempt may be made at once; and thus I succeeded instantly in pushing a lump of gristly steak into the stomach of an elderly lady, who lay back on a sofa gasping for breath, and was already black in the face.

Pharyngotomy and Œsophagotomy.—These operations consist in opening the gullet at one or other part; either for the removal of an impacted foreign body, or occasionally, in stricture, for the purpose of conveying food into the stomach.

The left side of the neck is usually selected; the œsophagus, inclining rather to this side, is there more accessible. An incision is made of sufficient length along the anterior border of the sterno-mastoid muscle, betwixt it and the trachea. The skin, platysma, and cervical fascia having been divided, the dissection is carried directly backwards, avoiding the carotid sheath and larynx or trachea. The omo-hyoid muscle may be divided, but the thyroid arteries should, if possible, be avoided in this deep dissection. Having reached the pharynx or œsophagus, a bougie, sound or catheter, had better be passed through the mouth into the cavity, and made to project as a guide on which to cut the opening into the gullet. The aperture may then be enlarged, either by dilatation with forceps, or by further incision with a blunt-pointed bistoury, to an extent sufficient for the extraction of the foreign substance, or for the introduction of a feeding-tube.

Use of the Stomach-Pump.—This apparatus is more often used for evacuating the stomach in cases of poisoning, than for the administration of liquid nutriment. A gag, with a hole in it, having been placed between the jaws of the patient's mouth, for the easy passage of a flexible tube without compression by the teeth, the tube is introduced through the gag, and passed cautiously down the *back* of the pharynx, thus avoiding the rima glottidis, and thence down the œsophagus into the stomach. For children, an elastic catheter of large size may be used. Having then attached the tube to the nozzle of the pump, or the catheter being connected by a piece of india-rubber tubing, the stomach is injected moderately full with warm water by working the pump, a pint or two being thrown in; then, reversing the action of the instrument, the water or admixture with the contents of the stomach is pumped up again. If the aperture in the tube become stopped up with undigested food, the action of the pump should be reversed sharply, to clear the passage; or, this failing, the tube must be withdrawn, washed out, and repassed into the stomach. Care must be observed not to withdraw the whole quantity of water injected, lest the mucous membrane of the stomach be sucked up into the apertures of the tube, as would happen if the stomach were empty. Water should be thrown in and pumped out, until it returns colourless and the stomach is thus completely washed out. Emetics are generally preferable to this mechanical mode of emptying the stomach, whenever vomiting can be *excited*, assisted by freely swallowing diluents.

For the administration of liquid *food*, the stomach-pump may be employed in like manner, only that the fluid is simply injected and not withdrawn.

CHAPTER L.*

DISEASES OF PHARYNX AND ŒSOPHAGUS, LARYNX AND TRACHEA.

FAUCES.—TONSILS and UVULA.—TONSILLITIS.—Acute inflammation of the tonsils is denoted by diffused redness and rapid swelling of the tonsils, which may almost meet, leaving only a chink between them. Commonly only one tonsil is affected. Pain, at first not acute, but rather as if the part had been bruised, is diffused over the back of the mouth and much increased by any attempt at swallowing; tenderness also is felt in the side of the neck and under the angle of the jaw. The saliva accumulates in the mouth and dribbles away, the patient holding his mouth slightly open as if to relieve the sense of strangulation, and speaking with a thick nasal voice. The tongue is loaded with a creamy fur, and the breath fœtid; there is considerable throbbing headache, and rather sharp fever. The state of the tonsils is readily seen on opening the mouth, by slightly depressing the tongue with the finger, or with a wooden pen-holder or pencil.

The *cause* of acute tonsillitis seems to be exposure to cold in conjunction with some constitutionally disordered state of health, especially the strumous dyscrasia. Gout and rheumatism have some influence in predisposing to tonsillitis, but the malady is essentially an affection of youth, a great majority of the cases occurring from the age of puberty to the twenty-fifth year. On the other hand, tonsillitis is excessively rare after fifty. As one tonsil recovers from the inflammation, the other often becomes affected. The individual is sometimes subject to recurring tonsillitis, at intervals of a few months.

The inflammation *terminates* in resolution, or in adults not unfrequently in abscess; but suppuration is rare in childhood, apart from scarlet fever.

Treatment.—In a majority of cases the internal administration of guaiacum or aconite, given opportunely at the outset of the disease, cuts short the crescent inflammation. It is useless, however, to exhibit these drugs later than twenty-four hours after the commencement of the local symptoms, as their specific action cannot then be exerted. Local measures consist in hot fomentations or a mustard poultice from ear to ear, and sucking small pieces of ice. Any unfavourable constitutional state of the general health must be rectified, and without much lowering treatment. Abscess should be opened early,—as soon as fluctuation can be detected; and carefully, by a knife of limited cutting edge. In puncturing the abscess, the edge should be turned towards the middle line, never outwards,—thus to avoid the risk of wounding the internal carotid artery. The relief obtained is very great, and the inflammation soon subsides, generally, however, leaving the patient much pulled down, notwithstanding the shortness of the illness.

CHRONIC ENLARGEMENT OF THE TONSIL.—Sometimes resulting from repeated inflammation, this hypertrophied condition of the tonsil more often occurs in children of a scrofulous constitution without previous phlegmon. Insidious and painless, the enlargement usually produces no other symptoms than those arising from the mechanical occlusion of the tonsils. Hence some difficulty of swallowing and breathing, the child snoring at night, and awaking in alarm. The voice is muffled, and there is more or less "throat-deafness" from other associated causes. Occasionally the hypertrophy attains to such an extent that the pharynx is almost occluded, and respiration is carried on inefficiently, and with considerable effort. As a result of this state of things, after a time, contraction of the chest-walls sometimes takes place, and a permanent diminution in the capacity of the thorax becomes established. In some cases the tonsils are very much diseased, and the retained secretions become decomposed, so that they communicate great fetor to the breath, and doubtless also exercise a pernicious influence on the general health, by contaminating the air which passes over them during inspiration.

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* Revised and much enlarged by Morell Mackenzie, M.D.

Superficial ulceration sometimes supervenes from time to time, and acute inflammation frequently occurs. The abnormal secretions may become inspissated and hardened, so as to form veritable calculitic concretions.

Treatment.—Constitutional measures are of the greatest importance. A general tonic plan of treatment, in the form of steel wine or the other preparations of iron, bark, cod-liver oil, and a nutritious, well-regulated diet, should be carried out. Sea-bathing is often most advantageous. Stimulating applications of nitrate of silver or iodine, though often employed, can scarcely affect the condensed areolar or fibrous tissue of which the enlarged mass consists. In order to effect any good, a caustic sufficiently strong to destroy to some depth the part to which it is applied must be used. London paste (a combination of caustic soda and unslaked lime) is very efficient for reducing the hypertrophy. It is sold as a powder, which is moistened with a little water and rubbed up to a creamy consistency when about to be employed. It should be applied to small patches of the diseased tonsil, by the aid of a hard pen-holder pared down at one end, so as to form a broad flat extremity. Immediately afterwards the application should be washed off by cold-water gargling. In this way successive layers of the diseased glands, of considerable thickness, can be gradually destroyed.

Excision of the tonsil is the most efficient local remedy, but it should be reserved for an extreme state of chronic enlargement, when any of the already mentioned symptoms threaten to be detrimental to the general health. The mouth being kept widely open and the tongue gently depressed, the tonsil may be seized with a vulsellum, but not drawn out of its bed, and a sufficient quantity removed with a protected, blunt-pointed bistoury, or the same partial excision can be performed by means of a guillotine or tonsillotome. This instrument, of which there are two forms, was invented in America about half a century ago, but has since undergone some modifications. In Physick's tonsillotome, the tonsil is encircled by a strong rim of metal, and a broad blade is then pressed down against it with the thumb. (Fig. 710.) In Fahnestock's instrument (Fig. 711), the excision is performed by a ring of steel sharpened on its internal circumference, which, when it encloses the tonsil, is drawn forwards towards the operator. Moreover, this guillotine is provided with two or three prongs, which transfix and steady the gland during the operation. Physick's tonsillotome can be used readily with one hand, whilst the other hand is applied under the angle of the jaw, so as to press the tonsil into the instrument. With the aid of two instruments, one for the right and the other for the left side, the removal of both tonsils is the work of a few seconds. The tonsil-guillotine is made in three sizes, as, unless it fits the tonsil with some accuracy, the gland is liable to be pushed on one side, instead of being cut through or transfixed, by the knife or prongs. I prefer the tonsillotome to the bistoury, especially for children, as it is a steadier mode of excision. This instrument can be used by the operator standing in front of the patient, for the excision of either tonsil; whereas, in removing the right tonsil with the bistoury and vulsellum, the operator must stand over the patient from behind, unless he be perfectly ambidextrous. Both tonsils may be operated on at the same sitting. A very efficient plan of arresting the hæmorrhage, if it be at all excessive, is to make some tannic acid into a thick paste with water, and to let the patient swallow about a teaspoonful of the mixture. In the act of deglutition the styptic is forced into the interstices of the cut surface of the tonsil, and the bleeding ceases at once.

Fig. 710.*

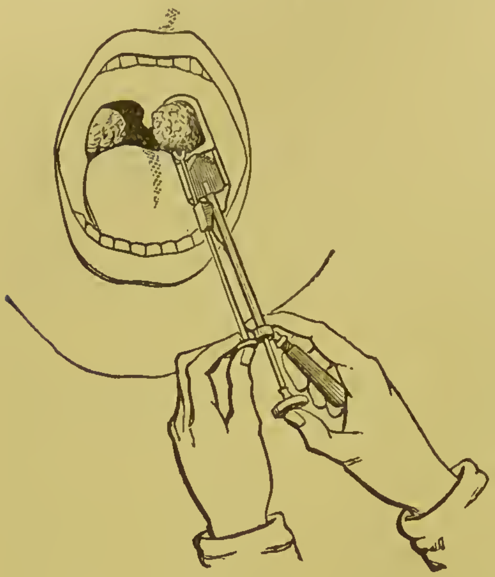
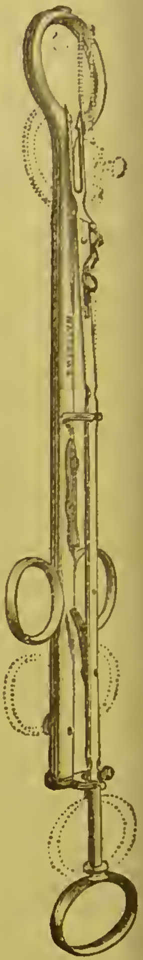


Fig. 711.†



Elongation or Relaxation of the Uvula.—Thickening, without elongation, of the uvula sometimes occurs; but an elongation or relaxation without thickening is the more common state. It appears to consist of an excess of mucous membrane, the azygos muscle not participating in the hypertrophy. The membrane may extend an inch beyond the extremity of the muscle, hanging down as a thin, narrow slip of this tissue, with a pointed extremity. When of this length, it touches the back of the tongue or even the epiglottis. Constant irritation occasions a spasmodic cough, while the tickling sensation may excite nausea or even vomiting. The patient's life is sometimes thus rendered quite miserable.

The *cause* of this hypertrophy generally seems to be chronic catarrh, or an habitual over-exertion of the voice. Hence its elongation is not uncommon among clergymen and public speakers. It often arises in those of a gouty diathesis.

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* Tonsillotome of defective construction. The prong is not used now, and only one hand is employed.

† Fahnestock's guillotine.

Treatment.—Astringents topically applied have some beneficial influence. Tonic treatment of the general health is an important adjunct, but the apparent causes adverted to must, of course, be removed when circumstances permit. Should relaxation still continue in spite of all remedial measures, a portion of the pendent uvula must be cut off. This may easily be done by seizing the extremity with polypus-forceps, and snipping off, with blunt-pointed scissors, so much as to leave the stump of the natural length of the uvula. A combination of forceps and scissors—an instrument of American invention—has been used for this purpose,—the uvula being held and cut off at the same time.

TUMOURS OF THE VELUM PALATI.—(1.) *Fibro-cellular* or warty tumours are usually attached to the free border or upper surface of the soft palate. Having a painless character, and being of slow growth, they are often only discovered when mechanically inconvenient by dropping down behind the root of the tongue. These tumours can be removed with forceps and scissors, care being observed to snip them off as near to the base of the pedicle as possible.

(2.) *Cysts*, mucous or sebaceous, are sometimes met with in the soft palate, containing respectively a thin, glairy fluid, or yellowish-white fatty matter. They must be laid open by a free incision, and their interior touched with a stick of nitrate of silver.

Abscess of the velum presents a globular swelling of the whole palate, accompanied by the red blush and pain of inflammation. It must be opened early and freely with a sharp-pointed, protected bistoury.

PHARYNX and ŒSOPHAGUS.—ACUTE PHARYNGITIS.—Inflammation of the pharynx, occurring generally as a continuation of a similar condition of the fauces and soft palate, but rarely as an independent affection, has often an erysipelatous and diffuse character. It sometimes terminates in purulent infiltration of the subcellular tissue. Sloughing of the mucous membrane occurs in the malady known as cynanche maligna, or putrid sore throat. This is sometimes an epidemic affection, and is always due to blood-poisoning. The pharynx acquires an ashen-grey appearance, and large portions of the mucous membrane and sub-mucous tissue become sphacelated even down to the muscular fibre. An eruption of herpes, precisely similar to the herpes of the skin, occasionally occurs on the mucous membrane of the pharynx. It is the affection spoken of by ancient writers under the name of *herpes gutturis*. This kind of sore throat is extremely painful.

The *local treatment* in all these cases, except the last, which is seldom an affection of any danger, should be soothing. The *constitutional treatment* should consist in the administration of quinine with mineral acids, and easily digested nourishment and alcoholic stimulants. Laryngotomy may have to be performed, owing to impending suffocation from œdema or spasm of the glottis. But when purulent infiltration has taken place, with considerable swelling, extending perhaps down the œsophagus to its cardiac end, swallowing becomes impossible, and recovery is almost hopeless.

Chronic Pharyngitis generally consists in an affection of the racemose glands of the mucous membrane, known as "granular pharynx" or "clergyman's sore throat." The diseased glands become distended by inspissated and unhealthy secretion, so as to form rounded granules, which are usually most numerous on the posterior wall of the pharynx. In some cases the thickened secretion exudes from the minute orifices of the glands, and forms small white prominences, presenting a very characteristic appearance. Troublesome throat-irritation is often present.

The *treatment* of this affection is to improve the general health, which is usually debilitated, and to destroy the diseased glands by a strong caustic. In mild cases the solid stick of nitrate of silver pressed against the granules or into the glandulæ may be effective, but in most instances the London paste will have to be used, in the manner described under the treatment of enlarged tonsils. Two or three granules may be destroyed every other day, but if applied too frequently the paste causes excessive inflammation.

Post-Pharyngeal Abscess occasionally forms in the cellular texture behind the pharynx, as an idiopathic disease in children; more rarely it results from caries of the cervical vertebræ, or from the impaction of a foreign body.

The *symptoms* are difficulty of deglutition, and perhaps dyspnœa, owing to pressure on the larynx; or nasal intonation, if the posterior nares be occluded. On examining the interior of the pharynx, a tense, fluctuating swelling may be seen and felt. This must not be mistaken for a polypoid or other solid growth of the walls or cavity of the pharynx. Pharyngeal abscess may burst into the mouth, or extend downwards under the sterno-mastoid muscles and present in front of the neck.

The *treatment* consists in evacuation of the matter by a well-timed puncture with a sharp-pointed, protected bistoury at the most dependent part of the abscess. The pus discharged has an offensive smell, not unlike that of a rectal abscess.

Ulceration of the pharynx is usually a manifestation of Syphilis or Scrofula; as such it forms part of the general pathology of these diseases, and the treatment will be found in the chapters relating thereto. A pharyngeal phthisis, pathologically similar to the same disease as it affects the larynx or lungs, has recently been described by Isambert of Paris, and Fränkel of Berlin. The deposit of tubercle which gives rise to this malady sometimes occurs primarily in the pharynx, but most frequently it is coincident or posterior in date to pulmonary consumption. Considerable ulceration is often present, and is diagnosed with difficulty from syphilis, unless close attention be paid to the constitutional condition.

TUMOURS.—*Fibro-cellular*, *fibrous*, and *fatty* tumours of the pharynx are occasionally met with; giving rise to the symptoms of abscess—difficult deglutition, and perchance impeded respiration, with a swelling in the pharynx, and perhaps in the neck. The characters of this swelling and its antecedent history will be the grounds of diagnosis. Practically, the particular kind of growth is less important than the size, shape, position, and attachment of the tumour. The pedunculated character generally prevails, in pharyngeal tumours. *Epithelial* cancer is sometimes met with, in the usual flattened patches of this form of malignant growth.

The *treatment* of any pharyngeal tumour consists in early removal by operation—a proceeding necessarily restricted to the pendulous form of growth. Laryngotomy may have to be performed, prior to drawing the tumour forwards over the larynx and excising it through the mouth. Pharyngotomy might be preferable to this double operation, if the tumour be accessible to incision through the neck.

STRICTURE OF THE ŒSOPHAGUS.—This condition may be the result of certain distinct diseases of the œsophagus, producing a contracted state of this tube, which is commonly designated *organic* or permanent stricture to distinguish it from *spasmodic* stricture of the œsophagus.

(1.) *Organic* stricture may be of *traumatic* origin—a *cicatrix* resulting from ulceration produced by the impaction of a foreign body, or may be occasioned by swallowing some acrid poison, as sulphuric acid. The latter mode of origin gives rise to a valvular *fold* of the mucous membrane, as an intestinal stricture consequent on dysentery. *Cancerous* thickening of the œsophagus may be epithelial, or medullary, or scirrhous. Malignant disease of the œsophagus almost invariably occurs at one of three positions; viz., most frequently opposite the cricoid cartilage; next, near the cardiac orifice of the stomach; and, lastly, opposite the bifurcation of the trachea.

Symptoms.—At first, slight dysphagia is experienced in the passage of solid food to the stomach. This increasing, the patient restricts himself to fluid food. At length, fluids are sipped only a few drops at a time, and perhaps partially rejected. Constant hunger tortures the patient day and night, yielding, however, at last to loss of desire for food; rapid emaciation and declining strength ensue. An almost never-failing symptom is the expectoration of a glairy fluid, a combination of saliva and mucus, which in health continually passes down the gullet, but in cases of obstruction collects above the seat of a stricture, and requires to be ejected from time to time. If ulceration takes place, expectoration of a semi-purulent and offensive secretion denotes this change, the breath also becoming perceptibly fœtid.

Hamburger's method of œsophageal auscultation affords valuable evidence in all cases of obstruction, but this method of examination requires much training and constant practice. The cautious introduction of an œsophageal bougie will declare the existence of *a* stricture, for the instrument comes to an obstruction or passes with difficulty. Before passing the bougie, care should always be taken to ascertain that no thoracic aneurism obstructs the passage. The *kind* of stricture must then be determined. Scirrhous stricture presents a limited and smooth extent of contraction; no pus or blood follows the withdrawal of the instrument, but simply mucous discharge; there is no tumour in the neck, no cancerous enlargement of the cervical glands, nor cachexia. Epithelial or encephaloid stricture differs or contrasts in all these particulars: a larger and irregular surface of contraction, through which the bougie passes roughly; pus and blood, or the latter more especially, with shreds of tissue, follow the withdrawal of the instrument; while in some cases an elongated tumour is to be felt at the root of the neck, with cancerous enlargement of the cervical glands, and there is often cancerous cachexia.

(2.) *Spasmodic* stricture is distinguished by the intermittent character of the contraction; it being sometimes present, sometimes absent, and situated more often in the pharynx than the œsophagus. The dysphagia intermits, and seems to be influenced mainly by the patient's attention being directed to or diverted from the complaint; the other symptoms—hunger, emaciation and loss of strength—are far less pronounced, and, indeed, are often altogether absent. The disease occurs most frequently in hysterical females. The introduction of a bougie is at first resisted, but the stricture soon yields under gentle pressure. A pathognomonic symptom is the sudden ejection of the bolus during the act of swallowing; the morsel passes down for a certain distance without stoppage, and is then forcibly expelled from the mouth with a sudden jerk.

Dysphagia may be *unconnected* with stricture, but dependent on some extrinsic cause or causes which diminish the calibre of the gullet by compression or obstruction. Such are—tumours connected with the pharynx; morbid conditions of the larynx, *e.g.* œdema; tumours in the neck; aneurism of the aorta or of the innominate artery; intrathoracic tumours; dislocation of the sternal end of the clavicle backwards; impaction of a foreign body in the gullet. The diagnostic differences of these various conditions may be gathered from other sections of this work.

Treatment.—*Organic* stricture, of whatever kind, is incurable. *Dilatation*, by means of bougies increasing in size, may afford partial and temporary relief But the risk of perforating the œsophagus should be remembered, a risk proportionate to the structural disorganization and contraction of the passage. This fatal misadventure has happened in the hands of the most skilful Surgeons. The instrument has been known to find its way into the mediastinum, into the cavity of the pleura, or into that of the pericardium. The principal use of a bougie is to determine the existence of a stricture, its situation and nature, and thus to complete the diagnosis of this affection—due caution being observed in passing the instrument.

Nutritive enemata will tend to support the strength and prolong life; while washing out the mouth with whatever fluid is most relished, and swallowing perhaps a little of it from time to time, proves an agreeable occupation to the patient. In cancerous stricture, laudanum or other anodynes, administered in the enemata, will assuage the sufferings of this condition.

Spasmodic stricture is sometimes amenable to the general constitutional treatment of hysteria. At the Hospital for Diseases of the Throat, valerianate of zinc is largely employed in these cases. The most effective agent, however, is galvanism, applied directly to the interior of the gullet by means of my œsophageal electrode. The constant current must be employed, by the aid of a battery containing about twenty cells. The electrode should be passed down as far as the seat of apparent stricture, and held in position for a few seconds. At first only five cells should be used, but the number may be increased gradually up to twenty, and the time during which the electrode is held in the œsophagus may also be augmented, according as the patient becomes more tolerant of the remedy.

Gastrotomy, or the operation of opening the stomach by an incision through the abdominal walls, has been performed, for the purpose of directly introducing food into the organ, when the œsophagus is impassable. Practised first by Sédillot, and since by Fenger of Copenhagen, Cooper Forster, and others, it has hitherto always rapidly proved fatal. The first-named authority thus performs this operation:—The patient lying on his back, the Surgeon, standing on the right side, makes a crucial incision, each line of which is about one inch and a half in length, on the left side of the mesial line of the abdomen; two fingers' breadth to the inner side of the costal cartilages, and about one-third nearer to the ensiform cartilage than to the umbilicus—having previously satisfied himself by percussion and palpation that the liver is not in his way. The dissection is carried through the abdominal wall, and the peritoneum opened. Then, feeling with his left index-finger for the left border of the liver, and following this upwards, the stomach is reached. The organ is seized with forceps, drawn forwards, and its structure recognized. The anterior wall of the viscus is then fixed to the edges of the integumental aperture, by three or four points of suture, and an opening afterwards made into it about midway between its two extremities and a little above the lower margin. When, in the course of a few days, union of the wall of the stomach to the parietal peritoneum has become securely established, nutritive injections should be administered through a silver tube passed into the artificial aperture, which is thus kept patent. The value of this operation has yet to be decided by the results of further experience.

Paralysis of the Œsophagus.—This affection occasions inability of swallowing; but it is unattended with spasm or pain, and the introduction of a bougie meets with no obstruction. It sometimes depends on centric disease, either of the brain or spinal cord, and cure in such instances will probably be impossible. Paralysis of the œsophagus is also met with in the aged and debilitated, either as the result of disease of the peripheral nerves of the part, or as a myopathic lesion. Loss of power of the œsophagus, unaccompanied by any marked evidence of general debility, is also occasionally encountered in adults and young people. An idiopathic and purely local weakness or partial atrophy of the muscular apparatus of the gullet appears to exist in these cases.

Treatment consists in the administration of nourishment by the stomach-pump or enemata. Strychnia and other nervine tonics might perhaps be tried with advantage. Electricity will often be found of the greatest value, especially in those instances where the disease is dissociated from any centric nerve-lesion. The interrupted (faradic) current may be applied by means of the œsophageal electrode, in the same way as galvanism is recommended for the treatment of spasm.

Dilatation and Sacculation.—These conditions of the œsophagus are of rare occurrence. Instances of the former have been recorded by Sir Charles Bell, Rokitansky, Mondière, Barker, and others. A remarkable specimen of sacculation is preserved in the Museum of University College. The mucous membrane protrudes through the fasciculi of the muscular coat, forming very distinct pouches.

The *symptom* of either structural condition is marked dysphagia of a mechanical kind—the food, more especially, lodging in the pouches of a sacculated œsophagus. The ingesta seem to stuff the chest, without reaching the stomach, and a portion is soon vomited, or rather ejected from the œsophagus.

Treatment can seldom be curative. In the worst cases, feeding with the œsophageal tube or per rectum is often the only resource. Frequently, however, in the least pronounced class of cases, considerable relief may be afforded by the direct application of astringent solutions to the dilated portion of the gullet. In order to effect this purpose, a hollow bougie, made of flexible metal, and perforated at one end with a few small holes, should be passed down to the dilated part of the œsophagus. A solution of perchloride of iron or nitrate of silver, etc., can then be injected by the aid of a small india-rubber syringe, the nozzle of which fits the end of the tubular bougie.

LARYNX AND TRACHEA.—*Laryngitis.*—Inflammation of the larynx is attended with more or less dyspnœa and aphonia, and generally with difficulty of deglutition, the severity of the symptoms being proportionate to the effusion and swelling. Ordinary *acute* laryngitis principally affects the mucous membrane of the larynx—the *œdematous* variety attacking the submucous cellular tissue.

Chronic laryngitis, resulting in thickening of the mucous membrane of the glottis, is attended, more particularly, with aphonia or various modifications of the voice—such as hoarseness, squeaking or broken voice, and with tickling, spasmodic cough. This form of the disease is commonly met with among clergymen, vocalists, public singers, and others, who are accustomed to use their voice to excess—often when catarrh exists.

Consequences.—The usual consequences of inflammation may follow laryngitis: abscess, sloughing and ulceration of the mucous membrane, perichondritis, and occasionally caries, etc., may supervene.

Diagnosis.—Visual examination of the upper portion of the respiratory tract can be made directly, by seating the patient opposite a good, clear white light, depressing the root of the tongue with a spatula, and requesting the patient to draw a deep breath. The laryngoscope supplies the means of completely exploring the larynx. Its application will be explained in connection with the treatment of laryngeal growths.

Spasm of the glottis gives rise to great dyspnœa; and, if prompt relief be not at hand, death will often ensue. This affection is very common in children of rachitic diathesis, and is known as *laryngismus stridulus*, pseudo-croup, or spasmodic croup. It is due to reflex irritation, such as teething or intestinal disease. In adults, it may occasionally occur with laryngitis, or it may be due to irritation of, or pressure on, the larygneal nerves by an aneurism or tumour. In females of an hysterical disposition spasm of the larynx is also met with.

Tumours.—Polypi, fibro-cellular, and fibro-plastic or epithelial growths, varying in size from that of a millet seed to a hazel-nut, may be attached to the vocal cords, the epiglottis, or to the mucous membrane within the larynx or trachea. Adenoid or glandular growths, vascular growths, cystic tumours, lipomata, and myxomata are also occasionally met with in the larynx.

The *symptoms* of such growths are—hoarseness or some other modification of the voice, perhaps aphonia, and sometimes a tickling, spasmodic cough. If the size of the tumour be sufficient to impede respiration and to exert pressure upon the neighbouring organs, we may also have dyspnœa and dysphagia. But the difficulty of breathing varies, in the same case, at different times; if the tumour is attached to the epiglottis by a long pedicle and hangs down into the larynx, it may be drawn into the glottis at every inspiration, and thus give rise to fits of suffocative coughing, or, if the growth is situated on the free borders of the vocal cords, it may assume a valve-like action, blocking up the rima glottidis at every expiration. The most certain method of determining the presence of a tumour in the larynx, and its exact position and attachment, is by examination with the laryngoscope. Not only can the seat of the growth be determined by this procedure, but its nature can also be ascertained. If this apparatus be not at hand, digital examination, through the mouth, may in some cases—especially children—enable the Surgeon to determine the density and seat of attachment of the growth; or, if the growth be situated on the epiglottis or at the superior opening of the larynx, it may perhaps be seen by pressing the larynx upwards and drawing the tongue well forwards, thereby bringing the epiglottis into view.

THE LARYNGOSCOPE.—This is an instrument devised for the purpose of obtaining a view of the interior of the larynx during life. The history of the laryngoscope dates back indirectly to M. Levret, a distinguished French accoucheur, who, in 1743, invented a laryngeal speculum or mirror. Subsequently, other names are more or less associated with this invention; Bozzini in 1804, and Senn in 1827; while Dr. Benjamin Guy Babington, in 1829, brought out the first laryngoscope, or glottiscope, as he named it—a laryngeal mirror combined with another mirror, held in the operator's hand, as the means of illumination. Bennati, in 1832, asserted his ability to see the vocal cords with an instrument devised by Selligue, a mechanic, whose contrivance was "a double-tubed speculum, of which one tube served to carry the light to the glottis, and the other to bring back to the eye the image of the glottis reflected in the mirror, placed at the guttural end of the instrument." Baumês in 1838, Liston in 1840, and Dr. Warden in 1844, were each successively associated with the art of laryngoscopy; and in 1844 the late Mr. Avery devised a laryngoscope whereby artificial light was made the source of illumination. In 1854 M. Manual Garcia conceived the idea of employing mirrors for studying the interior of the larynx during singing, by autoscopic examination. In 1857 Dr. Türck, of Vienna, endeavoured to employ Garcia's laryngeal mirror, with the aid of sunlight, in the wards of the General Hospital; and later in the same year, Czermak made use of artificial light, added the large ophthalmoscopic mirror for focusing the light, and, by his personal demonstration, brought the instrument into use in practical medicine.*

The laryngoscope consists of two parts: (1) a small mirror fixed to a long slender shank, which is introduced to the back of the throat; and (2) an apparatus for throwing a strong light, solar or artificial, on to the small mirror. For thus projecting the luminous rays, most laryngoscopists employ a second, larger mirror, which reflects the light from a lamp or the solar rays. When artificial light is employed, this illuminating mirror is slightly concave; when sunlight is used, its surface is plane.

The only principle concerned in the art of laryngoscopy is the optical law that, when rays of light fall on a plane surface, the angle of reflection is equal to the angle of incidence.

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* For further details, see "The Laryngoscope," by Morell Mackenzie, M.D. Third edition. Longmans.

Laryngoscopy is performed in the following manner:—The patient should sit upright, facing the observer, with his head inclined very slightly backwards. The observer's eyes should be about one foot distant from the patient's mouth, and a lamp burning with a strong clear light is placed on a table at the side of the patient, the flame of the lamp being on a level with the patient's eyes. The observer puts on the spectacle-frame with the reflector attached (Fig. 712), in front of his forehead, and directing the

FIG. 712.*

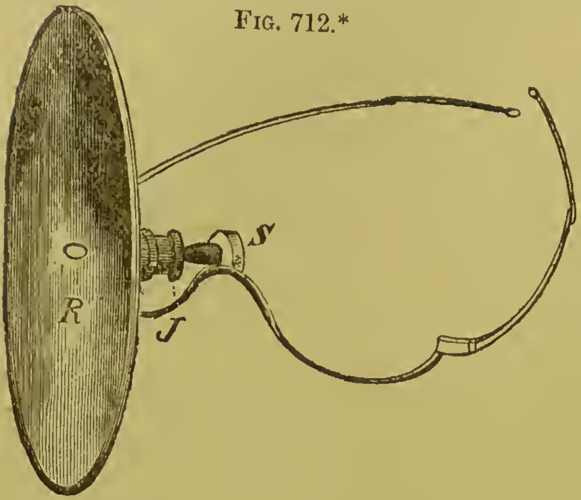
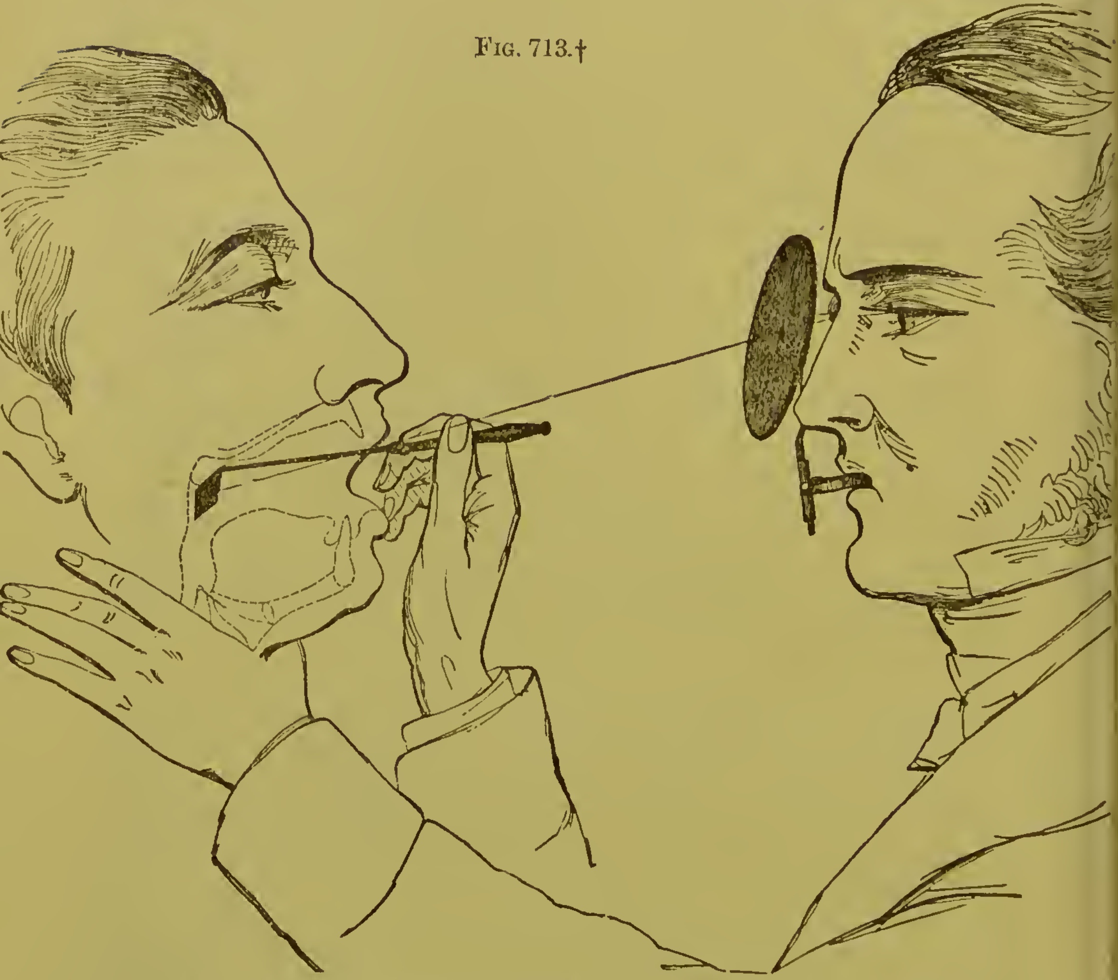


FIG. 713.†



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* Reflector attached to spectacle-frame, from which the upper halves of the rims have been removed.

† Shows the position of the laryngeal mirror, and the way first employed by Czermak, of holding the frontal mirror in the mouth. This plan has since been superseded by the spectacle-frame and frontal band.

patient to open his mouth widely, endeavours to throw a disk of light on to the fauces, so that the centre of the disk shall correspond with the base of the uvula. This projection of a luminous disk on to the back of the throat requires some practice, and it may be facilitated by inclining the reflector at a suitable angle before putting on the spectacle-frame. The tongue of the patient should now be protruded, and held, if necessary, between the thumb and finger, enveloped in a thin towel; the observer then introduces the laryngeal mirror to the back of the throat, having previously slightly warmed its reflecting surface over the chimney of the lamp, in order to prevent condensation of the expired air. This introduction of the mirror, so as to avoid producing faucial irritation, requires some nicety of manipulation and practice. The handle of the mirror being held like a pen, it should be introduced quickly to the back of the throat, its face directed downwards, and away from the tongue; the posterior surface of the mirror rests on the uvula, which is pushed upwards and backwards towards the posterior nares. (Fig. 713.) The observer raises his hand a little, and directing it outwards, towards the corner of the mouth, the inclination of the mirror is altered and its face brought more towards the perpendicular, while the hand is kept entirely out of the line of vision. This rotatory movement should be effected slowly, so that it can be arrested directly the larynx comes into view. Ambidexterity is very desirable in introducing the laryngeal mirror, and absolutely essential in the application of remedies to the larynx. The patient must then be taught to hold out his tongue himself.

"In some cases, on introducing the laryngeal mirror, only the epiglottis may be visible, with perhaps just the tips of the capitula Santorini at the posterior part; whilst in others, the entire length of the vocal cords, the ventricular bands (false vocal cords), the small cartilages of Wrisberg and Santorini, a portion of the cricoid cartilage,

FIG. 714.*

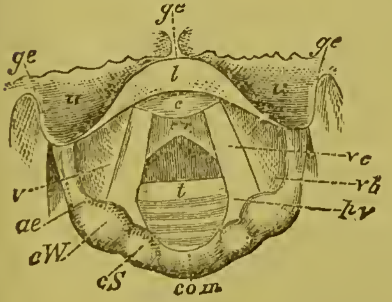
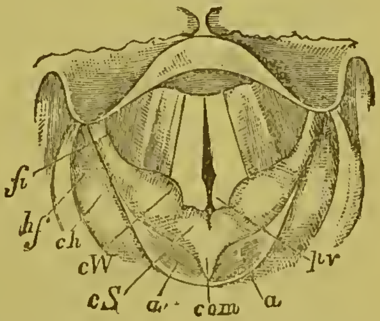


FIG. 715.†



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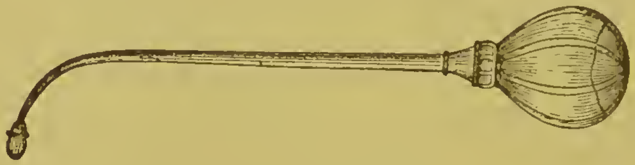
* Laryngoscopic drawing, showing the vocal cords drawn widely apart, and the position of the various parts above and below the glottis during quiet inspiration (after Mackenzie)—*g e*, glosso-epiglottidean folds; *u*, upper surface of epiglottis; *l*, lip of epiglottis; *c*, cushion of epiglottis; *v*, ventricle of larynx; *a e*, ary-epiglottic fold; *c W*, cartilage of Wrisberg; *c S*, capitulum Santorini; *com*, arytenoid commissure; *v c*, vocal cord; *v b*, ventricular band; *p v*, processus vocalis; *cr*, cricoid cartilage; *t*, rings of trachea.

† Laryngoscopic drawing, showing the approximation of the vocal cords, and the position of the various parts in the act of vocalization (after Mackenzie)—*f i*, fossa innominata; *h f*, hyoid fossa; *c W*, cartilage of Wrisberg; *c S*, capitulum Santorini *a*, arytenoid cartilages; *com*, arytenoid commissure; *p v*, processus vocalis.

the rings of the trachea, and perhaps even the bifurcation of the bronchi below it, can be seen with perfect distinctness. The view varies, in different cases, between these two extremes." (Figs. 714, 715.)

TREATMENT OF LARYNGEAL AFFECTIONS.—*Laryngitis* is to be met by the ordinary treatment of inflammation, promptly applied; in its acute form, the inhalation of soothing vapours, such as the vapour benzoini (Throat Hospital Pharmacopœia), is indicated; local depletion by means of leeches may also be applied, and a good purgative should be administered. Diaphoretics will also tend to cut short the progress of the affection. In the *œdematous* variety, if the swelling of the mucous membrane is sufficiently great to impede respiration, scarification with a guarded knife must be resorted to. If the dyspnœa increases, and suffocation becomes imminent, tracheotomy must be performed without delay. *Chronic* laryngitis is principally amenable to topical treatment. The best applications for this form of disease are solutions of chloride of zinc (gr. xx., ad. ℥i.), perchloride of iron (ʒi. ad. ℥i.) or glycerine of tannin. These remedies may be applied with brushes of suitable forms, or with the laryngeal syringe (Fig. 716), of which Gibb's is one of the best. The nitrate of silver is only to be used when an actual destructive process is going on.

FIG. 716.*



CROUP, or laryngeal diphtheria, is an acute disease attended with the formation of a false membrane, which is deposited upon the exposed surface of the mucous membrane. The question of tracheotomy is often raised in connection with this affection. Liston, and many of the most experienced Surgeons of recently passed generations, were of opinion that the tracheal false membrane rendered the operation useless; whereas Professor Spence, with an unusually large experience of ninety-one cases, affirms that the obstruction and irritation arising from the presence of this membrane justify recourse to tracheotomy without delay, whenever all remedies have been actively tried in vain—an opinion which has been strongly confirmed by the important statistical tables of Krönlein,† and the interesting work of Solis Cohen.‡ Both these authors, indeed, go further, and agree with Trousseau and other continental observers, who recommend the operation to be done in the first stage, or early in the second stage of croup, before the blood-poisoning and the exhaustion of the patient have become too great to enable him to rally from the shock of the operation.

The result of operation is, on the whole, very encouraging. In Spence's ninety-one cases, the mortality after the operation was seventy-seven per cent., whilst in Krönlein's recently published statistics it was seventy per cent. This is a large proportion, considering that surgical interference was the only chance of saving life.

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* Dr. Duncan Gibb's laryngeal syringe.

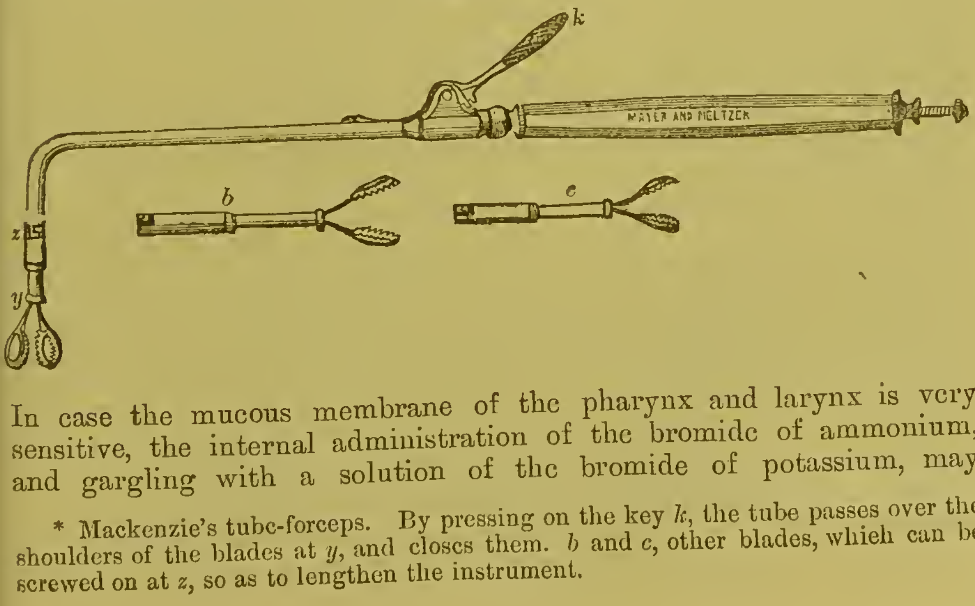
† Langenbeck's "Archiv." bd. xxi., heft ii.

‡ "Croup in its Relations to Tracheotomy." Philadelphia, 1874.

Spasmodic affections of the larynx in adults are often relieved by warm, sedative, and antispasmodic inhalations. In females, where the spasm is generally of an hysterical character, attention must be paid to the nervous disorder itself—not less than to the symptoms. In children, however, where the spasm is frequently due to some remote irritation or to some cachectic state, such as rachitis or hydrocephalus, the prognosis is often very unfavourable. Tonics, such as cod-liver oil and iron, are indicated, and every care must be taken to remove the cause of the attacks, and to prevent their recurrence. Farinaceous food should be strictly forbidden. Musk and chloral hydrate are very useful. When suffocation is imminent, tracheotomy should be performed without delay. In hysterical spasm the operation is also sometimes necessary, but cases of the most severe character sometimes yield to mental impression or physical shock. Some years ago, the author of this work (Mr. Gant) was called to see a young woman who was gasping for breath, and seemed so nearly on the point of asphyxia, that he was induced to have immediate recourse to tracheotomy. Having made the incision through the skin, respiration suddenly became free, and the purple flush of the face disappeared. He at once discontinued the operation. When the bowels had been thoroughly evacuated of scybalous matter, and this source of irritation removed, the dyspnœa never returned.

TUMOURS of the larynx may be removed by various operative procedures, evulsion with forceps being the method now most commonly employed. Growths, however, may be removed by various cutting processes, and either excision, abscission, or incision may be practised. Excision is best effected with cutting-forceps; abscission, by means of sheathed knives, scissors, guillotines, or écraseurs; incision or scarification, with the aid of guarded scalpels. In this country, Dr. Walker, of Peterborough, first succeeded in casting a loop of thin silver wire around the base of a laryngeal growth, and then detaching it by tightening the wire-ends drawn through a cannula. This operation has since been successfully performed by Gibb, Stoerk, Johnson, and others.

FIG. 717.*



In case the mucous membrane of the pharynx and larynx is very sensitive, the internal administration of the bromide of ammonium, and gargling with a solution of the bromide of potassium, may serve to diminish the irritability of those parts, and facilitate the performance of the operation; but sucking a little ice generally produces sufficient anæsthesia. For removing laryngeal growths I generally employ my cutting-forceps, which are bent upon the shank at a right angle. These instruments are made in two ways, one to open transversely, and the other to open in an antero-posterior direction. By means of these forceps a growth, situated in any part of the larynx, can be removed with little trouble. I also sometimes employ my tube-forceps, which are closed by pressing on a key in the upper part of the instrument, and are extremely convenient—especially for beginners. (Fig. 717.)

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* Mackenzie's tube-forceps. By pressing on the key *k*, the tube passes over the shoulders of the blades at *y*, and closes them. *b* and *c*, other blades, which can be screwed on at *z*, so as to lengthen the instrument.

Cauterization is not often resorted to, owing to the difficulty of limiting the action of the caustic. The best caustic is the "London paste," which should be applied with a wooden or glass rod, suitably curved. Fused nitrate of silver, prepared in the manner described, may be used for this purpose. The galvano-cautery, first employed by Mitteldorpf, has yielded satisfactory results in the hands of Voltolini and others.

Thyrotomy—or division of the thyroid cartilage; *Laryngotomy*—*supra*-thyroid in the thyro-hyoid membrane, or *infra*-thyroid in the crico-thyroid membrane.—These operations, which are *extra*-laryngeal, may be resorted to for the removal of growths, when they threaten the life of the patient and when it is impossible to operate successfully through the mouth. The peculiar circumstances under which one or the other of these procedures will be appropriate will presently be discussed, but here it may be remarked that a *combined* method of operative treatment may sometimes be found necessary; laryngotomy or tracheotomy, to relieve the urgent dyspnœa; the growth being subsequently removed through the mouth.

Operation of Thyrotomy.—As a precaution against suffocation during the operation of thyrotomy, I formerly recommended a preliminary operation of tracheotomy; but later experience has convinced me that this measure may generally be dispensed with. Should this operation be necessary on account of dyspnœa, the Surgeon should introduce Semon's tampon-cannula (a modification of Trendelenberg's), and thereby prevent the flow of blood into the trachea during the subsequent procedure. The operation is performed as follows:—An incision is made through the skin exactly in the median line, over the thyroid cartilage, from the notch above, down to the upper border of the cricoid cartilage; the thyroid cartilage is then cautiously divided with a stout scalpel, or, if it be in an ossified condition, a small semicircular saw must be used. Care should be taken to avoid penetrating the larynx until the whole of the cartilage is divided, as the entry of air provokes coughing and laryngeal spasm. The alæ are now to be drawn widely apart by means of two retractors, held by an assistant on each side. To make more room, if necessary, in the laryngeal cavity, transverse incisions may be made in the crico-thyroid membrane below, or in the thyro-hyoid membrane above, or in both, and on one or both sides. In some cases the cricoid cartilage has been divided, but enlargement in this direction seldom gives additional facilities. The intra-laryngeal growth being exposed, by the aid of a strong, reflected light, the polypus or excrescence should be seized with a fine forceps and snipped off by means of small curved scissors, or it may have to be removed in fragments with cutting-forceps. A firm touch or two with nitrate of silver or with the galvano-caustic will usually suffice to destroy the base, and to arrest any further hæmorrhage. The two alæ of the cartilages must then be brought evenly together with silver sutures, and the edges of the integumental incision are readily held in apposition by means of adhesive strips.

Thyrotomy was originally suggested by Desault towards the end of the last century; but the operation was first performed by Brauers, of Louvain, in 1833; some years afterwards by Ehrmann, of Strasburg; and afterwards by Gurdon Buck, of New York. Since the introduction of laryngoscopy, the operation has been more generally practised both in America and on the continent. The merits of this operation have been the subject of discussion between Mr. Durham and myself,—Mr. Durham urging the propriety of this operation as an "earlier, bolder, and more ready resource," for the removal of laryngeal growths; whilst I would restrict the operation to "extreme cases," where life is imperilled by dyspnœa or dysphagia. My conclusions rest upon a careful analysis of the *results* of forty-eight cases of thyrotomy—including thirty-seven on which reliance had been placed "to justify and encourage" the more frequent resource to this operative procedure. Thus, in relation to danger to life, omitting all cases which survived more than a few weeks, there were four deaths directly referable to the thyrotomy—a mortality of 8·33 per cent. With regard to respiration, the results have been far from encouraging—fifteen out of the forty-eight cases having been compelled to wear a tracheal tube. As to the vocal effects, in 77·77 per cent. the voice was lost or modified; in only 22·22 per cent. was it restored. Lastly, reproduction or incomplete removal of the laryngeal growth occurred in 38·46 per cent. of the non-malignant cases.

These unfavourable results are more than supported in a very able statistical work recently published by Dr. Paul Bruns.* This author's analytical comparisons of the results of treatment by each method are based on an examination of more than 100 cases of thyrotomy and over 1000 cases treated by endo-laryngeal methods. Dr. Bruns remarks† as follows: "I gladly join in Mackenzie's judgment ('Brit. Med. Jour.,' 1873), who only sanctions the operation 'when there is danger to life from suffocation or dysphagia, and then only after an experienced laryngoscopist has pronounced it impossible to remove the growth *per vias naturales*'—only I would prefer to say, 'if he has tried this method in vain.' For, as we have seen, even an experienced laryngoscopist is very rarely able to say that the endo-laryngeal method has no chance of success, as, even under the most unfavourable conditions, complete success has been obtained."

Application of Topical Remedies to the Larynx.—The most satisfactory method of treating laryngeal affections, when of an inflammatory character, is by the direct application of suitable remedies to the affected parts. This is best done by means of squirrel's or camel's hair pencils, which may be cut square at the end, if the application is to be freely made, or pointed, if only a small spot is to be touched. The pencils should be firmly attached to, and fixed in, a convenient handle. The laryngeal sponge-holder, which is provided with a fresh piece of sponge at every application, is a useful and cleanly instrument. The following is the best mode of accurately applying medicated solutions:—The tongue of the patient being protruded from the mouth, and firmly held by his right hand enveloped in a towel or handkerchief, the mirror is properly introduced and held in the left hand of the operator, who now introduces the brush with his right hand and touches the affected part of the larynx. Various kinds of syringes have been devised for the purpose of injecting fluids into the laryngeal cavity. Among them may be mentioned Türck's laryngeal syringe and Rauchfass's injector. Powdered substances are sometimes introduced into the larynx by means of insufflators, which are curved, hard—rubber tubes, with an attached flexible tube and mouthpiece. The curved tube having been charged with the medicated powder and introduced into the pharynx of the patient, a single puff will suffice to convey the remedy to the diseased organ. For applying solid nitrate of silver, special "porte caustiques," provided with the proper laryngeal curve, have been devised, but it is better to have the nitrate fused to the extremity of a piece of silver or aluminium wire.

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* "Die Laryngotonne zur Entfernung intralaryngealer Neubildungen." Hirschwald: Berlin, 1878.

† Ibid., p. 167.

The remedies most generally applied to the larynx are solutions of the chloride of zinc (gr. x. or gr. xx., ad. ℥i.), the perchloride of iron (ʒi. or ℥ ii., ad. ℥i.), sulphate of copper (gr. xx., ad. ℥i.), carbolic acid (ten to thirty grains to the ounce of water). Solutions of nitrate of silver are not so useful, owing to the nausea and spasm which is so often superinduced by them. Powdered nitrate of silver, mixed with starch or sugar, and morphia powders (morph. gr. $\frac{1}{4}$, amyli. gr. $\frac{1}{4}$) are often of the greatest value in laryngeal disease, the latter remedy being particularly serviceable in laryngeal phthisis.

LARYNGOTOMY and TRACHEOTOMY.—The windpipe may be opened by surgical operation; either to establish Artificial Respiration for a time, or to remove a foreign body. According to the situation of making the artificial aperture, the operation is designated: Laryngotomy, when the crico-thyroid membrane is thus opened: Tracheotomy, when the trachea is the seat of operation.

The various conditions of injury or disease which cause a mechanical impediment to the respiration, and which may require either of these operations for relief, have been noticed in other parts of this work.

Laryngotomy is very readily performed. The head of the patient being thrown back, the depression between the thyroid and cricoid cartilages is easily touched with the point of the finger. A vertical incision is made in the middle line, about an inch long, with a narrow-bladed, pointed bistoury or scalpel; this incision passing between the sterno-thyroid muscles, a cross cut through the crico-thyroid membrane at once enters the air-passage. The air rushing in and out of the aperture, and the immediate freedom of the respiration, shows that the object of the operation is accomplished. A curved laryngotomy-tube of suitable size should be introduced, and retained by tapes fastened round the neck. Very little hæmorrhage occurs, but a small branch from the superior thyroid artery, running across the membrane, may be divided and require torsion or ligature.

Tracheotomy.—This operation consists in cutting down upon the trachea, in some part of its extent, and then dividing two or three of its cartilaginous rings; a more difficult and perhaps dangerous proceeding than laryngotomy, particularly if the neck be short and fat, the veins turgid, and the trachea deep, small, and restless,—moving up and down with each effort of hurried and forcible respiration. All these adverse conditions attend the operation in children.

The head being thrown straight back, an incision is made exactly in the middle line of the trachea, about an inch and a half to two inches long, extending from the lower margin of the cricoid cartilage downwards nearly to the top of the sternum. (Fig. 718.) The skin, superficial fascia, and fat are thus divided; the opposed margins of the sterno-hyoid and sterno-thyroid muscles are then separated with the scalpel, and the veins in front of the trachea drawn out of the way to either side; any unusual artery, discovered by its pulsation under the finger, is also avoided. The isthmus, or connecting central portion of the thyroid gland, may have to be drawn upwards; for, if wounded, the hæmorrhage is very troublesome. In children, the remnants of the thymus gland and vessels lie immediately over the trachea; the thin, flattened lobes should be separated, and, with their vessels, drawn to either side. A tenaculum is dipped into the upper part of the trachea, which is thus drawn upwards and steadied on the stretch; then, taking advantage of a favourable moment of exposure, the Surgeon pushes the knife, with a slight jerk, into the lowest exposed portion of the trachea, and, carrying a small incision upwards, divides two or three of the cartilaginous rings of this tube. Occasionally, the rings being in an ossified state, they must be divided with a pair of strong scissors. The air rushing in and out again shows that the windpipe is opened, but special care should be taken to prevent any oozing of blood, arterial or venous, into the trachea. A curved tube of a conical shape, flattened laterally, as recommended by Liston (Fig. 719), or a rectangular tube, should be introduced into the tracheal aperture. The cannula should be of sufficient size to completely fill the tracheal incision, and allow of free respiration, "without," as Trousseau remarks, "any whistling noise." In children, with croup, the tube should not be introduced until any false membrane that is present has been expelled or extracted. The introduction of the tube is sometimes attended with difficulty, owing to the elasticity of the tracheal rings, which partly close up the aperture even after division. One side

Fig. 718.

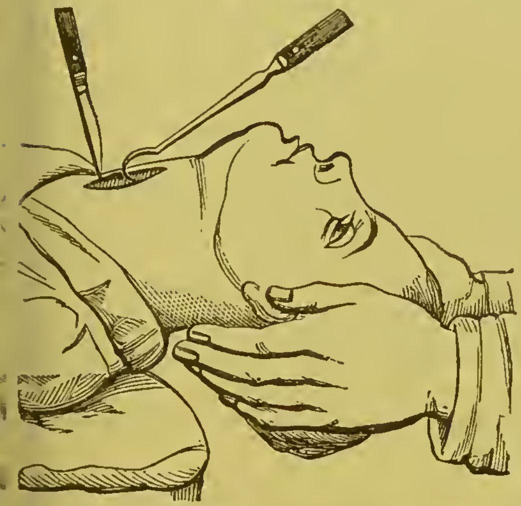
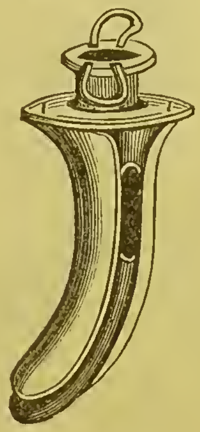


Fig. 719.



of the incision in the trachea may be held aside with a hook, while the tube is slipped in; or the aperture may be made and expanded with M. Garin's trachea-forceps dilator; or Dr. Fuller's bivalve tube can be readily introduced, closed, and a cannula passed through it. A *double* tube is always preferable to a single one, especially if there be much expectoration, as the inner tube can be taken out and cleansed. The tube is retained by tapes round the neck. (Fig. 720.) When the patient wishes to cough or speak, he must be instructed to close the orifice of the tube with his finger. The rectangular tracheotomy-tube (Fig. 721) of Mr. Durham, though not quite so easy to introduce, is much more easily retained than the old-fashioned curved cannulæ. The old curved tube, in order to be retained, has to pass at least an inch down the trachea, whilst Mr. Durham's tube does not reach down further than half an inch. The old tube also exercises a constant pressure on the anterior wall of the trachea, and is easily tilted out in fits of coughing. The descending portion of the right-angled tube, on the other hand, adapts itself to every movement of the windpipe. A firm handle, with a key terminating in an oval point, passes into the cannula, and enables the operator to introduce the instrument into the incised windpipe. An ingenious screw arrangement also permits the horizontal portion of the cannula to be fixed to the shield in such a way that it corresponds to the thickness of the tissues between the skin and the trachea. For many years no other tracheotomy-tube has been used at the Hospital for Diseases of the Throat, where eight or ten operations are performed annually.

FIG. 720.

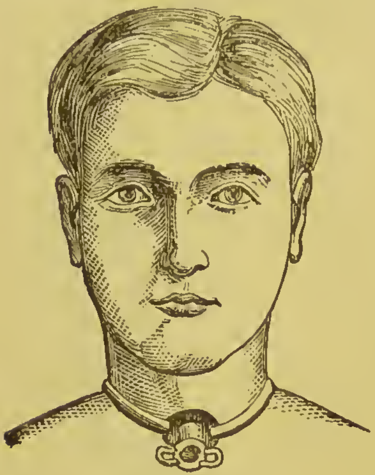
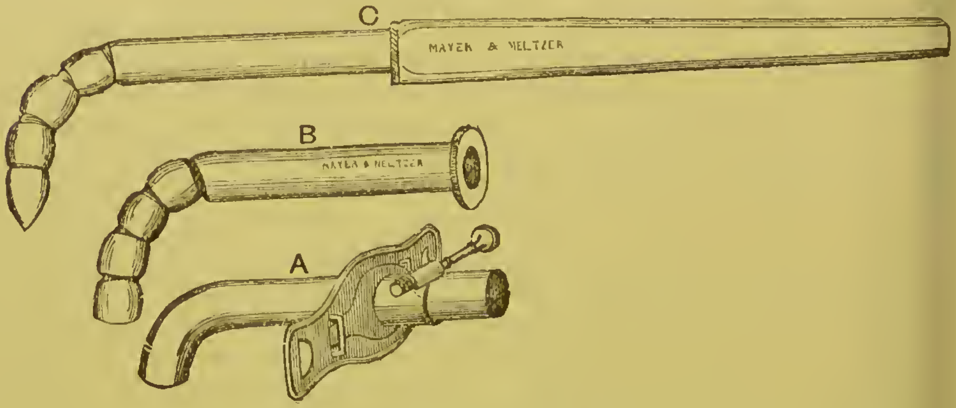


FIG. 721.*



After-treatment must have regard to the free passage of air through the tube, and of air duly warmed,—now that the breath is drawn more directly into the lungs, instead of passing through the nose or mouth to the larynx. The tube may be kept free of any obstruction by removing any mucus, collected there, with a feather from time to time. Or, if the double tube be used, the inner one can be readily withdrawn, as occasion requires, and having been well cleansed with warm water, is easily re-inserted. The final removal of the tube is determined by the establishment of natural laryngeal respiration. When the tube is withdrawn, the wound heals more or less readily. In *chronic* laryngeal disease, or if there be any liability to the recurrenee of the trouble, it will often be necessary to retain the tube for an indefinite length of time. A double tube, provided with a pea-valve, should then be worn. The patient is thus enabled to inspire through the tube, and to expire—and thus speak—through the larynx. At night the valve should be dispensed with. From wearing the tube some irritation and expectoration are not infrequently induced, but this generally soon subsides, leaving, perhaps, a thickened or almost cheloid growth around the opening in the neck as the only local result.

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* A, Durham's tracheotomy-tube, showing the screw arrangement for lengthening and shortening the horizontal portion of the tube; B, the inner tube, which has a lobster-jointed termination; C, the plug and handle for introducing the cannula.

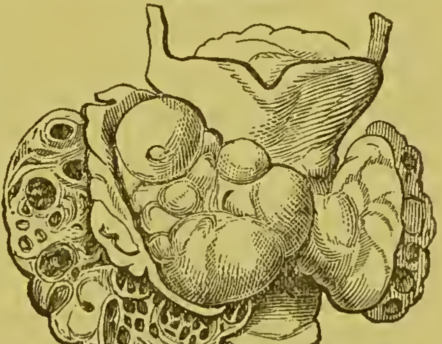
The removal of any *foreign body* from the larynx or trachea must of course be effected before passing in the tube, in either of these operations, if undertaken for this purposo. The exact situation of any such substance having been ascertained by passing a probe through the artificial opening in the windpipe, forceps of suitable size and shape are then cautiously inserted and the body extracted.

CHAPTER LI.

DISEASES OF THE THYROID GLAND. THE PAROTID GLAND. TUMOURS OF THE NECK.

THYROID GLAND.—(1.) BRONCHOCELE OR GOITRE.—This condition is an enlargement of the thyroid body, existing in one of three forms:—as *hypertrophy* of the proper structure of the thyroid, or *simple* bronchocele; cysts imbedded in the substance of the gland, containing a glairy or bloody fluid, and perhaps becoming proliferous, by growths springing from their interior, forming *cystic* bronchocele (Fig. 722); or as an enlargement of the thyroid vessels in and around the gland, constituting a vascular swelling, or *pulsating* bronchocele, and as being associated with an unnatural prominence or protrusion of the eyeballs and an anæmic condition, this form of the disease is sometimes known as *exophthalmic* bronchocele. The state of the eye-balls has been referred to an enlargement of the eye itself, Dr. Stokes attributing the prominence to an

FIG. 722.



increase of the vitreous and aqueous humours; but it is generally referred to some morbid condition of the structures in the orbit, behind the globe,—effusion of serum, increase of post-ocular fat and cellular tissue, congestion of the orbital veins, or other such cause. Combinations of these three conditions of bronchocele are not unfrequently met with; cysts associated with hypertrophy, or vascular enlargement with cysts. Modifications also may be produced by morbid changes; extravasations of blood, and its alterations, resulting in pigmentation; or fatty and calcareous degenerations taking place.

Symptoms, and *Diagnosis.*—Certain appearances and phenomena are common to all three forms of the disease. A swelling, corresponding in situation and shape to the thyroid gland, is presented in front of the neck; and which has a soft elastic character. Usually, both lobes of the gland are affected, and the tumour is bilobular; rarely, however, equally so; the right lobe is commonly the larger; occasionally, the middle lobe or isthmus is principally affected. The tumour always follows the movements of the trachea, to which it is attached, and of the œsophagus as connected therewith; the swelling therefore rises upwards towards the chin when the patient is directed to swallow, and then lowers again to its original position as the act of swallowing ceases. This rising and falling of a tumour in the neck during deglutition is diagnostic of bronchocele from any other tumour, not implicating the thyroid gland, or directly attached to the trachea. When bronchocele has attained to a large size, this phenomenon is less observable, and therefore less characteristic. The skin over the tumour is not discoloured, or in an otherwise unhealthy state.

The *mechanical* results of pressure on surrounding parts are proportionate to the size of the tumour. Difficulty of breathing, especially in a stooping posture, and of swallowing, or dyspnœa and dysphagia, with some congestion of the brain, arise from pressure on the trachea, œsophagus, and jugular veins; hacking cough also ensues from a diseased condition of the trachea itself. Spasm of the glottis, from irritation of the recurrent laryngeal nerve, may give rise to similar and more urgent symptoms.

Cystic bronchocele is distinguished from simple hypertrophy of the thyroid, or ordinary bronchocele, by tension and fluctuation in the cystic portions of the enlarged gland, and by a somewhat specially lobulated character, where the cysts partially project. The most marked instance of this form of the disease I ever saw, was in the Norfolk and Norwich Hospital, when I happened to visit that institution in the autumn of 1868. The patient, a young woman, was the subject of an enormous cystic bronchocele, which occupied the whole front and depth of the neck; extending laterally upwards from near the angle of the jaw on either side, downwards towards the clavicle, and from almost the level of the chin to the sternum. The whole mass looked like a pillow in front of the neck, tucked up under the jaw. The cysts were large, plainly fluctuating, and prominent.

Pulsating bronchocele is thus distinguished from ordinary goitre:—The size of the tumour varies considerably with the general condition of the patient as to rest or excitement, and their effect on the heart's action; the tumour rarely becomes large enough to produce any great deformity; and the purring thrill and loud murmur in the tumour, with jerking of the carotids, and the general symptoms—palpitation of the heart and prominent eyeballs—will complete the diagnosis.

Causes.—Common bronchocele, hypertrophy of the thyroid gland, occurs mostly in women, and commences about the age of puberty in this country. It may, however, be congenital, but not enlarge until puberty. It is frequently associated with some derangement of the menstrual function, and with an anæmic state of the general health. Hence the females affected have a pallid, weak, miserable appearance. Pregnancy alone not unfrequently induces enlargement of the thyroid gland. Endemic influence is remarkable; the disease prevails in Derbyshire, Nottingham, and the chalky parts of England; in the valleys of the Alps, Apennines, and Pyrenees. In Savoy, Switzerland, the Tyrol, and Carinthia, there are villages in which all the inhabitants, without exception, have these swellings. The hygienic cause generally assigned under these circumstances—the use of melted snow, or of water impregnated with calcareous or earthy particles—is not established with regard to the localities most productive of the disease. But it does arise in low, damp situations chiefly, and under hygienic circumstances favourable to anæmia and debility. The disease is often associated with cretinism and idiocy; seeming to have an hereditary character in imperfect physical and mental development. Billroth affirms that goitre is more common in persons with well-developed bones and brains.

Pulsating bronchocele is said to be independent of endemic influence. Injury to the neck has sometimes been noticed as an exciting cause of bronchocele, a twist or strain of the neck having, apparently, given rise to the disease.

Terminations.—Recent enlargement of the thyroid gland may disappear under treatment; but the disease is of very chronic character, and when it has continued for some years, it is mostly incurable. Common goitre seldom continues to grow after the fiftieth year, so that if previously harmless, it will probably then remain so. The pulsating form of bronchocele is apparently urgent, yet it very rarely proves fatal; unless accompanied with organic disease of the heart, dilatation and hypertrophy, particularly affecting the left side of the heart, with perhaps thickening of the auriculo-ventricular valves.

Treatment.—The *hygienic* conditions productive of the disease must, if possible, be changed; the patient being removed from a low, damp situation to a more airy locality. *Medicinal* treatment should have reference principally to the constitutional condition—anæmia. Iron, particularly the sulphate, may be administered with marked benefit, and Dr. Murray speaks highly of strychnia; but the curative efficacy of iodine was first shown by Dr. Coindel; and shortly afterwards Dr. Fyfe, of Edinburgh, discovered the presence of iodine in burnt sponge. Originally given as thus prepared, the iodide of potassium is now commonly prescribed. Topically also, iodine ointment, or that of the iodide of lead, may be rubbed into the tumour with advantage; or the emplastrum ammoniaci cum hydrargyro can be applied. But generally all local applications are comparatively useless. A seton has been employed successfully by Mr. Hey, of New York.

Ligature of the thyroid arteries, as the nutrient vessels, has been had recourse to. The difficulty and danger of this operative proceeding, its very questionable results, and the probability of other arterial branches becoming enlarged, constitute serious objections thereto.

Pulsating bronchocele would be most appropriately treated by ligature. Injection of perchloride of iron has been found serviceable, subject to the risk of considerable inflammation, suppuration, and pyæmia supervening.

Cystic bronchocele may be tapped here and there, and injected with tincture of iodine, in order to induce inflammation and adhesive obliteration of the cysts.

Excision of the thyroid gland should hardly be entertained; this operation is specially dangerous, owing to almost uncontrollable hæmorrhage, and the disease does not effect the general health nor peril life. The most suitable conditions are either simple or cystic bronchoceles, of small size, and situated more in the middle line of the neck; especially when such growths are prominent and movable. If resorted to, the operation must be performed by an incision in the middle line of the neck, so as to turn the tumour out of its bed, taking care to ligature the vessels as they are successively divided. Removal of any portion of the gland, as of the isthmus crossing the trachea, should be accomplished with similar precaution; and the remainder of the gland secured on either side by double ligature, previous to excision of the intervening portion. Successful results have followed the operation of complete excision, in a few cases, recorded by Dr. W. Greene, of Maaine, and by Dr. P. H. Watson ("Edin. Med. Journal," Sept., 1873). But, for the reasons already mentioned, it is a procedure not to be lightly entertained.

Tracheotomy may be performed for the relief of urgent dyspnœa, arising either from direct pressure on the trachea, or spasm of the glottis due to irritation of the recurrent laryngeal nerve.

(2.) *Inflammation* of the thyroid is rare; it arises spontaneously, perhaps, in scrofulous persons only.

(3.) *Fibrous*, *cartilaginous*, and *osseous* formations sometimes occur in this gland; *tubercle* is scarcely ever seen, and *cancer* in its medullary form is very exceptional (Rokitansky).

(4.) *Hernia Bronchialis* is occasionally produced by protrusion of the mucous membrane through the cartilages of the larynx or the rings of the trachea, as a result of violent exertions of the voice. Larrey met with it in French officers, and in the priests who, with their deep-toned voice, call the people to prayer from the minarets in Mohammedan countries—as I often heard them do at Scutari.

The tumour is soft and elastic, increased by any expiratory effort, and it disappears on pressure. The support of a compress is the only curative treatment.

Parotid Gland.—Parotitis or Mumps.—An inflammatory swelling of the parotid gland, involving the submaxillary and sublingual glands; and usually affecting both sides of the neck. Some pain and stiffness accompany this glandular enlargement; but suppuration rarely supervenes, although the swelling may be very persistent. It migrates, occasionally—by metastasis, as it is said—to the testicle, or to the breast in the female. Commonly seen in children, and sometimes in adults, the disease arises apparently from cold and damp, and has a slightly infectious character.

There is no danger in this affection, only considerable inconvenience. The *Treatment* consists simply in the topical application of warm fomentation or poultice, and stimulating embrocations when the swelling has become quite indolent. Saline aperients and tonics form the constitutional treatment. The metastatic affections must be treated as similar inflammatory swellings of the parts attacked.

TUMOURS.—(1.) *Glandular parotid tumour* is the most frequent tumour in connection with the parotid gland. It is probably developed in one of the lymphatic glands lying over the parotid, or perhaps in the fibrous envelope of the gland itself. It resembles the adenoid or glandular tumours connected with the mammary or prostatic glands, and is described by Bauchet as an hypertrophy of the parotid. It consists of fibrous tissue mixed with glandular elements, in which there are often portions of cartilage, and one or more cysts. A distinct capsule generally encloses and isolates the tumour.

This parotid tumour appears as a firm hard lump, situated generally below and behind the lobe of the ear, but sometimes in front of it. Growing slowly, and displacing the parotid and the parts contained therein, the tumour becomes buried deeply behind the ramus of the jaw. Besides deformity thence arising, hearing and mastication are interfered with; and perchance facial paralysis may occur on the affected side.

Treatment.—Removal of the tumour with a knife is the only cure, but the operation is both difficult and dangerous. A ⊢ incision will be most convenient; the vertical line passing down the posterior edge of the tumour, where it is most safely approached. It has been known to return a second and a third time, as in a case recorded by Langenbeck, at the end of a year, and again after five years the tumour was successfully extirpated.

(2.) The parotid region is subject to other tumours, which, however, are not at all peculiar to this part of the body. Thus we recognize—*fibro-cellular*, *fibrous*, *fatty*, *cystic*, *cartilaginous*, and *cancerous* tumours; as growths incident to the parotid region.

The removal of any such tumour must be determined by its size and apparent connections; a cancerous tumour being irremovable probably, owing to its infiltrating character.

Excision of the parotid gland is an operation scarcely to be entertained in a work on Surgery; the irregular connections of the parotid, and the important structures passing through it—the external carotid artery and facial nerve—render the extirpation of this gland a surgically impracticable operation. Portions of the gland may be removed with an overlying tumour.

TUMOURS OF THE NECK.—(1.) *Enlargement of the cervical glands*, in scrofulous persons, is a common affection; appearing in the form of round, puffy or indurated, submaxillary lumps; indolent or suppurating. A chain of rather large, rounded tumours, along the anterior margin of the trapezius, on both sides of the neck, is said by Miller to be characteristic of syphilis; and these lumps, though indurated, never suppurate. They are sometimes the first, and the last to go, of any constitutional symptoms. Glandular enlargements of stony hardness, and involving the whole lymphatic chain, may be conjoined with exophthalmic goitre, as a result of the anæmic condition. Such enlargement resembles scirrhous affection, but has a totally distinct origin.

(2.) *Induration* of the *sterno-mastoid* muscle is not uncommon in hildren. It may be distinguished from any enlargement of the cervical glands, which lie posterior to the muscle, by two circumstances: in the one case, the swelling is within the sterno-mastoid, and its mobility varies with the contracted and relaxed state of the muscle; in the other case, the swelling is behind the muscle and is unaffected by its action.

This muscular affection is very curable in childhood, by counter-irritant and tonic measures; while glandular enlargements are obstinate and may be quite incurable.

(3.) *Enlarged Bursæ* are found in the anterior part of the neck, although rarely. These bursal tumours may be situated in front of the pomum Adami, or between the posterior surface of the hyoid bone and thyroid cartilage, or between the muscles of the tongue. The tumours rise and fall in the movements of deglutition, thus resembling cystic bronchocele; but their situation is partly distinctive, and puncture will determine the diagnosis, by the nature of the contained fluid.

Treatment consists in blisters, puncture, and injection of iodine.

(4.) *Cysts* singly, or aggregated and forming a multilocular tumour, —known as hydrocele of the neck,—may occur in either triangle of the neck, commonly the posterior triangle, or beneath the sterno-mastoid muscle. Such cyst or cysts may be situated superficially, usually more deeply; and sometimes become so numerous as to occupy the whole side of the neck. The contents of the cysts are various; serous or sanguineous fluid of a brownish colour, or sebaceous matter. (Langenbeck.)

The characters of the tumour thus produced are always similar; a tense and elastic, round, or somewhat lobulated swelling; varying in situation, prominence, and size. Deglutition and respiration may be more or less impeded. The diagnosis from *abscess* will be determined by puncture.

Treatment.—Tapping and injection with iodine. Suppurative action by means of a seton may be equally curative, but it is more hazardous. Extirpation will scarcely ever be practicable, owing to the situation of these cysts.

(5.) *Fatty* tumour (Liston), *fibrous* tumour, *cartilaginous* tumour (Spence), and *cancerous* tumours, are occasionally met with in the neck; *epithelial* cancer, rarely.

The removal of these growths must be guided by general principles, having regard to the situation and connections of the growth.

CHAPTER LII.

INJURIES AND DISEASES OF THE SPINE.

The Anatomical construction, and the Physiological or functional uses of the several parts, of the Spine or Vertebral column should be remembered, in relation to its Injuries and Diseases.

Anatomically, the Spine—so named from the series of spinous processes presented posteriorly—consists of three elementary portions:

the columnar portion, the canal, and the processes, articulatory, and those for the attachment of muscles.

The *functions* or *uses* of the Spine are threefold, and correspond to its anatomical elements. It is a *column* or pillar for sustaining the weight of the head and trunk, at the same time being a girder to support the ribs, and connect the bones of the extremities; an *elastic-jointed* mechanism for flexible motion; and an *osseous canal* for containing and protecting the delicate and vitally important structure of the spinal cord. But the integrity of the cord is also secured by three other special provisions. Firstly, by its central position in the vertebral column, the cord occupies neutral ground in relation to the forces which might cause sprain or fracture; so that in compression of the column forwards, and laceration of the posterior segment, the cord remains centrally in a neutral state. Secondly, the elastic and graduated flexibility of the column prevents the effects of shock, and abrupt motion, being communicated to the cord. Thirdly, its loose suspension in the canal, and enclosure in a layer of subarachnoid fluid, which acts as a water-cushion, will further resist concussion.

The flexibility of the vertebral column varies in different regions, the cervical, dorsal, and lumbar; being least in the dorsal region, where, compared with the length of this portion of the spine, there is a smaller proportion of inter-vertebral substance than in the cervical and lumbar portions of the column. To compensate for these various degrees of flexibility, certain curves are introduced near the respective junctions, to equalize the movements. The *weakest parts* of the column, and consequently the parts most liable to injury, are at the junctions of flexible to comparatively inflexible portions of the column. Hence, these parts are, the dorso-lumbar; the cervico-dorsal; the atlo-axial, regions.

The various kinds of injury and disease, including malformation, to which the spine is liable, may be conveniently arranged in order as follow:—(1) Wounds, involving the cord; (2) Sprain; (3) Fracture and Dislocation; (4) Concussion; (5) Compression; (6) Caries; (7) Lateral Curvature; (8) Spina Bifida.

INJURIES.—WOUNDS, like other injuries of the spine, owe their importance to the probability or certainty, as the case may be, of the cord being involved, primarily by the lesion itself, or secondarily by its inflammatory consequences.

The *causes* of any such wound are—stabs with pointed instruments, as by a sword thrust, or with a knife or fork; gunshot injury; fracture of the spine, implicating the cord by pressure of a displaced fragment. This latter cause of wound is associated with compression of the cord, and is the usual form of that injury.

Certain *symptoms*—those of paralysis, motor, sensory, or both—are common to a wound of the spinal cord, in any part of its extent; unless above the origin of the phrenic nerve, opposite to or above the third cervical vertebra, when death is instantaneous from paralysis of the diaphragm and other respiratory muscles, causing immediate asphyxia. But the symptoms of paralysis vary according to the *region* in which the cord is wounded—as in the cervical region, below the origin of the phrenic nerve, the dorsal, or the lumbar regions; and the corresponding symptoms, which indicate these injuries of the spinal cord, are fully described in connection with Fracture of the Spine.

Sprains.—The ligaments connecting the vertebræ, together with the muscles which lie in the vertebral groove on either side of the spinous processes, are liable to be overstretched and torn, sprained, or ruptured. Any such lesion will be more or less localized, according to the rigidity of the part injured, as in the dorsal region, or its elasticity, as in the cervical or lumbar regions,—where, the force being broken and distributed, the sprain will be more general.

The *symptoms* are sudden and acute pain in the part affected, which is elicited by pressure, or by any movement involving that part of the spine. The patient, therefore, lies in the position which insures rest. Swelling and ecchymosis may be well marked or scarcely perceptible; and the discolouration may not appear for some days after the injury. The *diagnosis* from fracture of the spine will be determined by the absence of any displacement in the vertebræ, the line of the spinous processes being straight, and their points level. The pain on pressure is not limited to the processes of one or two vertebræ, as in fracture; and the patient can erect the spine, though with painful difficulty, but without presenting any deformity. The symptoms of sprain continue for a longer or shorter period; a bad sprain in the loins lasting, perhaps, for a month or six weeks. Voluntary movement is gradually attempted as the pain induced passes off, and this will be the surest sign of progressive recovery.

The *causes* of spinal sprain are generally such occasions of violence as bend the column downwards and forwards, with a sudden and excessive depression. The force may be external, as by a heavy weight falling on the back when the lower limbs or the pelvis is fixed; the dorsal spine then acts as a long lever, the sacro-vertebral articulation being the fulcrum, and the superincumbent weight on the trunk representing the force forwards. The lumbar spine is thus sprained. A similar effect may be produced by the weight of the trunk itself, as when a person falls or jumps from a height, and alights on his nates. The to-and-fro twisting of the spine resulting from a railway collision, may produce the most severe sprain. Violent muscular efforts may sprain some part of the spine, as in the endeavour to lift a heavy weight, or in pulling; or by a sudden wrench in the act of starting forward from impending danger.

Complications, and *Consequences.*—Sprain in the lumbar region is not unfrequently complicated by *hœmaturia*, blood passing with the urine for several days after the accident. This arises from some lesion of one or both kidneys, owing to their contiguity to the lumbar spine. The quantity of blood lost varies. Generally, the urine has a deep red or brown colour, only for one or two days; it becomes clear and florid on the third or fourth day; and, in a day or two more, the urine resumes its natural appearance. Clots sometimes form in the bladder. Nephritis—inflammation of the kidney—is a rare consequence of this traumatic hæmaturia; an immunity, in connection with injuries of the spine, which is unexceptional in the experience of Mr. Le Gros Clark. Previous disease of the kidneys will predispose to hæmaturia from comparatively slight injury to the lumbar spine; as when associated with renal calculus, or with the congestive, early stage of albuminuria.

Hœmorrhage into the vertebral canal, with compression of the cord, and paralysis, is an occasional complication of spinal sprain. It will always be difficult or impossible to determine, by any differential symptoms, whether the intra-vertebral hæmorrhage be situated outside or inside the theca of the cord, and hence the source of the extravasated blood. Post-mortem examinations of clinically observed cases are wanting, to complete the solution of this interesting question.

Inflammation of Joints of the Spine.—A serious consequence of sprain of the spine is inflammation of the articulations; extending perhaps to the membranes of the cord, as spinal meningitis, or even involving the cord, as spinal myelitis. Suppuration within the vertebral canal may result, and thence compression of the cord. But the loose connection of the fibrous theca or dura mater within the canal, which has a distinct periosteum,—unlike the adherent dura mater within the cranium, which serves the purpose of periosteum,—is an anatomical condition unfavourable to the extension of the articulatory inflammation of the spine. The violence of the sprain is certainly no measure of the probability of inflammation supervening; comparatively slight injury having perhaps this consequence, while severe sprain may not be followed by inflammation.

The *symptoms* are those of paralysis, the inflammation being of a chronic character and leading to suppuration. In an early stage, the paralysis may be partial, depending on the compression of some of the spinal nerves, as they issue through the inter-vertebral foramina; in a later stage, the paralysis may become more general, from intrusion of the abscess into the vertebral canal, and compression of the cord, resulting in complete paraplegia. At this stage, chronic abscess around and within the vertebral canal, as the consequence of spinal sprain, might be mistaken for caries, with abscess and destruction of the bodies of the vertebræ. But the absence of angular deformity at the seat of disease by the upper portion of the column inclining forward, will probably settle the question of diagnosis. Spinal abscess from sprain may terminate by resolution, with the removal of compression-symptoms, and gradual restoration of the functions of the cord; leaving perhaps the diseased articulations in a state of anchylosis. Or, the abscess breaks, and continuing to discharge pus, the prognosis is unfavourable.

TREATMENT.—Uncomplicated sprain of the spine should be treated on the principles which relate to sprains of the joints generally:—(1) Perfect rest of the body, in the recumbent position, or on a prone couch; (2) Fomentations, warm and sedative, as by a decoction of poppy-heads, or a lotion of lead and opium; subsequently, stimulating applications, as camphor liniment, or the tincture of iodine; (3) Mercurials, as the bichloride, in small and continued doses, with bark, and good nourishment. Some sort of stay support may be requisite when the patient begins to get about.

The complications and consequences of spinal sprain must be treated as explained in connection with Hæmaturia, and Compression of the spinal cord from intra-vertebral hæmorrhage or suppuration.

FRACTURES OF THE SPINE.—*Structural Conditions.*—The several parts of a vertebra are liable to fracture. The processes, articular, transverse, and spinous, may severally be the seat of fracture; and in particular the spinous process. The arch is sometimes fractured on either side of this process (Fig. 723); and the body of the vertebra is liable to fracture obliquely, from behind forwards and downwards, or occasionally it may be comminuted. The ligaments corresponding to these several portions of bone are ruptured with fracture, more or less completely. In fracture of the body, the anterior and posterior common longitudinal ligaments are torn through. Displacement will depend on the line of fracture, and on whether the force producing it be direct or indirect. Thus, fracture of the body of a vertebra, and by indirect violence, as a fall on the head from a height, will occasion great displacement; the upper portion of the body being driven downwards and forwards, and the lower backwards and upwards, with excurvation of the spine posteriorly, so that the projecting point corresponds to the spinous process of the fractured vertebra. In proportion as the fracture is transverse, and the displacement a sliding forwards only, the spinous process of the broken vertebra is depressed and disappears, while the process of the vertebra below thus relatively projects. (Fig. 724.) Direct violence of an extreme kind will also produce displacement; as a gunshot injury to the spine. Comminution is mostly produced by violent flexion forwards, as Malgaigne alleged; but it may also arise from direct violence, applied in the opposite direction, as by a fall

Fig. 723.*

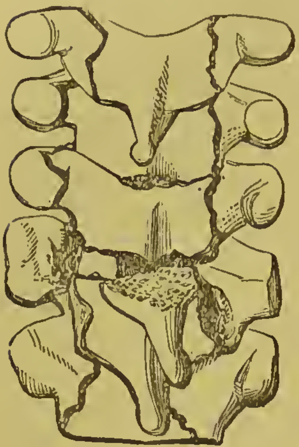


Fig. 724.†

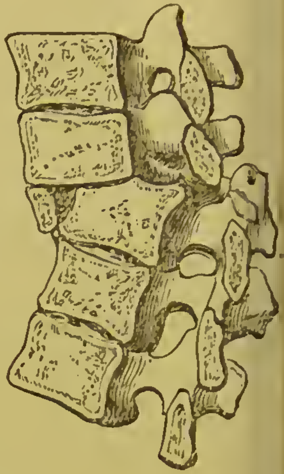


Fig. 725.‡

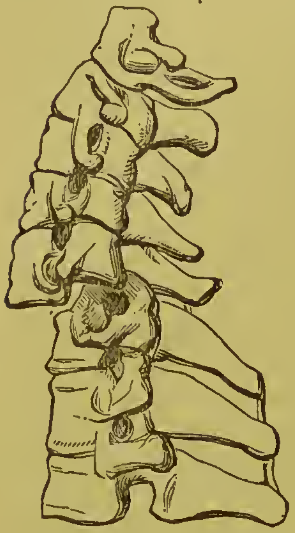
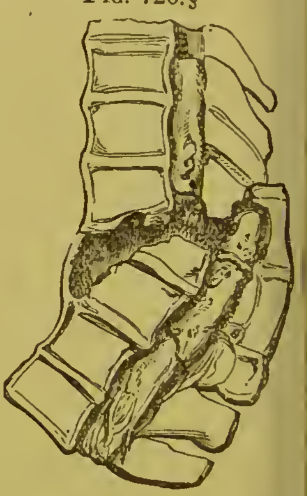


Fig. 726.§



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* Univ. Coll. Mus., 160.

† St. Thomas's Hosp. Mus., M. 19. Fracture through the anterior part of the body of the twelfth dorsal vertebra, with displacement of the eleventh forwards, carrying with it the detached fragment of the twelfth. The anterior common ligament is untorn. The spinal cord was compressed just above the cauda equina. Reparative deposit of new bone on the vertebral arch, opposite the seat of fracture.

‡ Univ. Coll. Mus., 3606. Dislocation forwards of the fifth cervical vertebra, without fracture. From a man who tumbled downstairs, whilst carrying a sack of flour. He was insensible, and died shortly after admission into the Hospital.

§ Ibid., 162. Fracture through the body of the ninth dorsal vertebra, with displacement of the upper portion forwards upon the lower to such an extent, that the dura mater and spinal cord are completely divided; but the anterior common ligament is entire, although stripped from the front of the vertebra below. The spinous process of the eighth vertebra has also been detached. The pleura was lacerated at the seat of injury.

on the back of the neck across an iron bar, in a case recorded by Hamilton.

Dislocation often accompanies spinal fracture; and dislocation of the articular processes in the back and loins cannot, perhaps, take place without fracture. In the neck, these two forms of injury may occur independently. (Fig. 725.) This difference is owing to the different direction of these processes in the three regions of the spine; in the cervical region having an oblique or almost a horizontal direction; while in the dorsal and lumbar regions they are vertical.

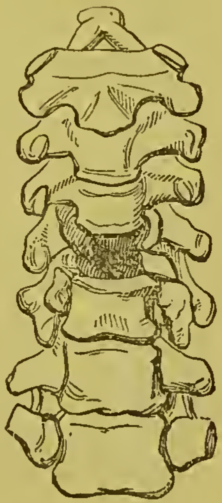
The spinal cord and its membranes suffer compression or laceration, in fracture with displacement of the bodies of the vertebræ (Fig. 726); but the membranes are comparatively rarely ruptured or torn, although the cord has been completely divided in some cases.

Arterial hæmorrhage in the substance of the cord is inconsiderable; the vessels which permeate the cord being minute and soon ceasing to bleed. But venous blood, from the large sinuses in the vertebral canal, collects in perhaps considerable quantity between the vertebræ and the dura mater; and particularly under the arches of the vertebræ, where the attachment of this membrane is loosest. Any such extravasation of blood will be an additional source of pressure on the cord.

Symptoms.—The symptoms of spinal fracture are both general and special, or pertaining to the particular region which may be the seat of fracture.

The *general* symptoms are, locally, some alteration of contour in the line of the spinous processes, depending on and proportionate to the *displacement.* The processes above the seat of fracture are depressed, and correspondingly prominent below. The transverse processes also may have become prominent, and the spine twisted on itself. Rarely can any mobility or crepitation be felt, unless the fracture be limited to one or other of these processes. But more or less swelling and discolouration are conspicuous. Pain is experienced at the seat of injury, and there is a notable inability to support the trunk erect. The general symptoms otherwise refer to injury of the *spinal cord,*—as also depending on the displacement. The functions of the cord are more or less completely suspended or destroyed. Thence, paralysis of sensation and voluntary motion below the seat of fracture; constipation, with involuntary evacuation of the fæces, which become blackish, pultaceous, and have an offensive odour; and retention of urine, which becomes ammoniacal, and is voided by a dribbling incontinence. Such are the regular symptoms. Priapism and emission of the semen may occur as occasional symptoms.

FIG. 727.*



Fracture in the upper part of the *lumbar* region produces—in addition to the general symptoms—a tympanitic condition of the abdomen; the intestines being almost suddenly distended with gas. In the upper part of the *dorsal* region, the thoracic respiration is embarrassed or suppressed, by compression of the cord above the origins of the intercostal nerves. At the *sixth cervical* vertebra (Fig. 727) fracture is attended with paralysis of the upper extremities; and above the *third* cervical vertebra, compression of the cord will be instantly fatal by asphyxia—the phrenic nerves thus being paralyzed.

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* Univ. Coll. Mus., 1, 59. Fracture of anterior portion of body of fifth cervical vertebra—apparently produced by forcible flexion of the neck; fragments of the bone project in front, and posteriorly the body is divided into halves by a vertical fissure, and the lower border projects slightly within the spinal canal. The articular processes of the fifth and sixth vertebræ are widely separated, the posterior common ligament having been ruptured. The arch of the sixth vertebra is fractured across its pedicles.

Causes.—External violence applied directly, or indirectly, to the vertebral column, represents the two modes of fracture-production. A blow or fall on the back is one mode of fracture; a fall on the top of the head, or compression of the trunk vertically, as between the box of a carriage and an archway, is the other, or indirect mode of producing fracture of the spine. *Gunshot* injury, as a cause of fracture, may be complicated by the lodgment of a foreign body, as a ball or portion of clothing.

Course and *Termination.*—The effusion resulting from inflammation is sometimes a further source of pressure on the cord, at a period subsequent to fracture-displacement and intra-spinal hæmorrhage. Bed-sores are extremely liable to form over the sacrum or other prominent points, even when subject only to the pressure of a water-bed; the vitality of the skin declining in consequence of the paralytic condition. A chronic inflammatory state of the bladder, with mucous or muco-purulent and ammoniacal urine, supervenes; and sloughing of the bladder, with extravasation of urine, I have known to occur. Increasing exhaustion accompanies the paralysis, and death ensues.

But the *period* of fatal termination which thus takes place in most cases, varies according to the situation of fracture, the degree of displacement also, and pressure therefore on the cord. Above the third cervical vertebra, death may not occur immediately, unless the fracture be attended with displacement. In nineteen cases, collected by Dr. Stephen Smith, wherein the odontoid process was fractured, at ages ranging from three to sixty-eight years, three survived for five days, and ten for several weeks or months; in one case, death taking place two years and three months after the fracture. Similarly, fracture of the atlas was not fatal until a year after the accident, in a case under Mr. Cline's observation; although port-mortem examination showed that the odontoid process of the axis was ever liable to fall backwards upon the cord. Fracture of both atlas and axis may not be immediately fatal, unless accompanied with sufficient displacement; one patient having lived five days, and another forty-seven weeks, and in the latter case bony union had occurred. Between the fourth cervical and the first dorsal, fracture is not generally fatal, under from three to ten days. With fracture in the dorsal region, the patient may live from two to three weeks. With fracture in the lumbar region, life may be prolonged from three weeks to two months, or possibly, many months. Recovery is not impossible. Even in fracture above the third cervical vertebra, three of the cases referred to recovered. In one, after the separation and escape of the odontoid process of the axis; in another, the body of this bone was discharged, and the process retained. A favourable result will be yet more probable, according to the absence of displacement, as in fracture of the more solid vertebræ of the lumbar region; the nature of the injury remaining undiscovered during life, and the fragments becoming united. (Figs. 728, 729.) Eleven such specimens have been collected by Dr. Wyman, of New York. Death resulting from *gunshot* injury of the spine showed a high percentage in the cases which occurred during the American War of the Rebellion; but it is instructive to note the declining ratio of mortality according to the seat of injury, from above downwards:—

FIG. 728.*

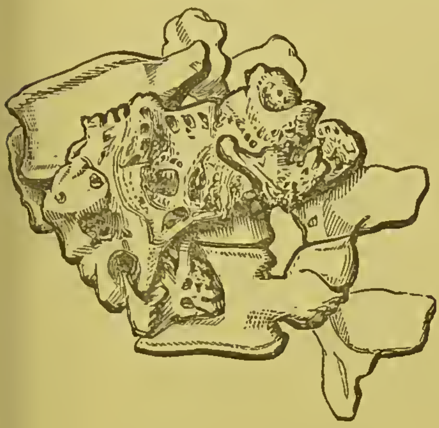
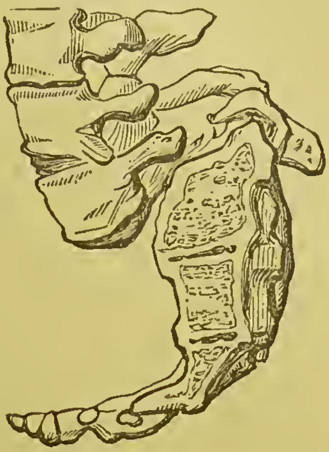


FIG. 729.†



Region.	*Cases.*	*Died.*	*Mortality.*
Cervical	91	63	70·0
Dorsal	137	87	63·5
Lumbar	149	66	45·5

Treatment.—The fracture itself cannot be treated. No displacement of consequence can well or safely be rectified; and no mechanical appliances can be applied effectually. Any injury to the spinal cord must be treated with reference to inflammation. The patient being placed in bed, flat on his back, to insure rest; local depletion by leeches may first be employed, followed by counter-irritation, cautiously, having regard to the tendency to bed-sores. Subsequently, the administration of strychnine in small and increasing doses, continued until slight tetanic twitchings are produced, will have the most beneficial influence on the paralysis. Electricity also may be employed, perhaps with advantage.

The state of the bladder will require the constant introduction of a catheter to relieve retention; while the treatment appropriate for chronic cystitis may have some avail in changing the character of the urine. The bowels must be carefully regulated by laxative aperients, such as castor oil, and enemata occasionally of turpentine and gruel.

Trephining the spine, in order to raise or excise any depressed fragments—as originally proposed by Paulus Ægineta—was performed by H. Cline, in 1814; and afterwards by Mr. Oldknow of Nottingham, Mr. Wickham of Winchester, Mr. Attenburrow, Tyrrel, and Sir A. Cooper; by Dr. Rhea Barton, and other American Surgeons; also by

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* St. Thomas's Hosp. Mus., 25^1.

† Univ. Coll. Mus., 170. Fracture of the arch of the last lumbar vertebra, extending through the upper part of the body of the sacrum; with dislocation of the vertebra forwards and downwards. No history. A dissecting-room specimen.

Laugier and Roux; making a total of about a score cases. All were fatal in their results, although four of them were questionably successful for a time—two by Dr. Patter, of New York; one by Dr. Blair; and perhaps a fourth by Dr. Gordon, of Dublin. If compression of the cord from hæmorrhagic extravasation could be diagnosed, the risk of trephining might be warranted, and the operation afford some relief; but, with compression from depressed fracture, the damage to the cord remains, *plus* the danger arising from the operation. In the case of an open wound, depressed fragments may be extracted, as in a case by Louis. Otherwise, this practice is properly condemned by Liston, Brodie, Malgaigne, and Gibson. In *gunshot* fracture of the spine, the removal of depressed fragments is not followed by any successful results of recovery, as with regard to the functions of the cord; except perhaps in cases where a broken spinous process has been removed,—without thus relieving compression, or exposing the cord This conclusion is fully established by an examination of the cases of such operative procedure by American Surgeons, in the War which has contributed so much rich experience to the annals of Military Surgery. The operation of trephining, in gunshot fracture, is as little sanctioned by the results of this experience; although the lodgment of a ball in the soft parts presents a complication which may be dealt with according to the general principles of treatment in gunshot wounds.

Bed-sores are produced by ulceration of a gangrenous character, as the consequence of prolonged pressure on prominent parts of the body, during any long and exhausting confinement to bed. But, in the practice of Surgery, bed-sores are specially apt to form in the course of fracture or other injury of the spine, which necessitates continued recumbency. The skin over the sacrum, more particularly, or other points, as the spinous processes of the vertebræ, the spines of the scapulæ, the trochanters, and the heels, is liable to undergo congestive inflammation and ulceration from continued pressure; these parts chiefly being in contact with the bed on which the patient lies. A congestive patch, here or there, appears, of a purplish-brown colour, attended with a pricking sensation, as if bread-crumbs were under the part; sloughing soon follows, involving the subcutaneous cellular texture, and thus forming an ulcer, which may not itself be of large size, but which is more or less extensively undermined. The integument can perhaps be lifted up as a flap around the ulcer. A thin sanious fluid exudes. This sore may remain stationary, but indolent and indisposed to heal. Or, the marginal skin melts away progressively, and the base of the ulcer deepens; so that the tendinous expansion over the sacrum may come away in shreds, and the bone be laid bare. Sometimes the tubercles of this bone become necrosed. Perhaps, spinal meningitis supervenes. At last, the patient sinks from exhaustion.

The formation of bed-sores is provoked by irritation or maceration of the integument, by perspiration, urine, or feculent matter having saturated the bed, from want of cleanliness; but there is always a special predisposition to such ulceration in enfeebled and aged persons; while the influence of paralysis and of certain blood-diseases is witnessed in the frequency of bed-sores after injury to the spine, and in the course of pyæmia or septicæmia, typhus, or other fevers. Prevention is nearly always possible. The nurse, if she understand her duty, or instructed by the Surgeon, will take every watchful precaution to avoid or remove any pressure upon prominent parts; remembering the painless and insidious character of the ulceration in most cases. Hence, the importance of using a well-stuffed bed, so that the patient shall not sink into hollows, and of observing that the sheet be kept free from wrinkles. A draw-sheet placed under the buttocks is very serviceable in aid of cleanliness, and the nurse should always use a bed-pan, and take care that the fundament be sponged and wiped dry, after any evacuation. It will be necessary to employ a urine-bottle, in case of dribbling micturition. The patient should be thoroughly examined from time to time, to see that no bed-sore is threatening. Exposed parts—the sacrum in particular—may be fortified by washing them with some slightly stimulant lotion; such as spirits of wine, or with the addition of two grains of bichloride of mercury to the ounce—as Brodie recommended—or a weak carbolic acid solution; or, the part may be mechanically protected with a layer of soap-plaster spread on thick wash-leather, or with a pad of cotton-wadding. A proper adjustment of ring-cushions or air-pillows will further aid in removing pressure; and the water-bed is often a most useful resource. Any abrasion of the skin may be painted over with collodion; when sloughing takes place, separation of the dead textures should be promoted by poulticing with charcoal or carbolized charcoal; and, afterwards, the clean ulcer may be dressed with a weak stimulant solution, as of perchloride of iron or tincture of myrrh. Care must still be taken to guard against pressure. Throughout the treatment, whether preventive or remedial, the patient's weak circulation and low nutrition must be invigorated, as far as possible, by tonics and nutritious food.

Concussion of the Spinal Cord.—This expression is used to denote a shock, shake, or jar of the spinal cord, as the immediate effect of violence, directly or indirectly applied to the Spine. This is attended with or followed by an impairment or loss of the functions depending on the integrity of the cord—symptoms of a paralytic character.

The *pathology* of injury referable to concussion of the spinal cord has been, and is still, disputed. It is argued that the peculiar anatomical construction of the spine, and the condition of the enclosed cord—the elastic and graduated flexibility of the one, and the loose, isolated state of the other, suspended in a tubular investment of sub-arachnoid fluid—are circumstances which render it highly improbable, if not impossible, that vibrations of force should be communicated to the cord. All these circumstances are of an opposite character in relation to the brain, which is subject to concussion from injury to the head. On the other hand, injury of the spine, accompanied with paralytic symptoms, is not unfrequently met with in which, upon examination during life, or after death, no fracture, displacement, extravasation of blood, or other cause of compression, can be discovered. Injury of this kind, distinguished by the absence of any perceptible structural alteration, is referred to concussion of the cord, in explanation of the peculiar functional symptoms. And analogy would seem to confirm this interpretation of the symptoms produced, although the intimate nature of the change in the concussed or shaken nervous structure cannot be demonstrated. We do not know—observes Mr. Erichsen—

how it is that, when a magnet is struck a heavy blow with a hammer, the magnetic force is jarred, shaken, or concussed out of the horseshoe. But we know that it is so, and that the iron has lost its magnetic power. So, if the spine is badly jarred, shaken, or concussed by a blow or shock of any kind communicated to the body, we find that the nervous force is to a certain extent shaken out of the man, and that he has in some way lost nervous power.

The *secondary* changes of structure which the spinal cord undergoes are those of inflammation, of a chronic character; and as affecting the membranes—chronic Spinal Meningitis, and the cord—chronic Spinal Myelitis; the former usually extending to, or being accompanied with, a similar affection of the cerebral meninges—chronic Cerebral meningitis.

In *Spinal Meningitis*, the structural alterations consist of increased vascularity of the membranes, the meningo-rachidian veins being engorged, and the vessels of the pia mater injected, in patches or uniformly; serous fluid, reddish and clear, or opaque from the admixture lymph, is effused, more or less in quantity, within the arachnoid, or there may be adhesion of its visceral and parietal surfaces, and puriform lymph in the sub-arachnoid space. In *Spinal Myelitis*, the inflammation affecting the substance of the cord, this undergoes softening and atrophy—the whole of the nervous substance even disappearing, and leaving nothing but connective tissue at the part affected. The extent of this structural change varies; the whole thickness of the cord may be affected at one point, or one of the lateral halves in a vertical direction, or it may be limited to the anterior or posterior aspect; or restricted principally to the central grey portion, rather than the circumferential part of the cord. When myelitis is consecutive to meningitis, the inflammatory softening may—according to Ollivier's observations—be limited to the white substance. These alterations of structure may have taken place in one region only; in the lumbar portion of the cord, most frequently; in the cervical, next in order of frequency; in the dorsal, less commonly. The whole length of the cord is very rarely affected. Induration, with hypertrophy, of the nervous substance of the cord—which resembles boiled white of egg—instead of softening and atrophy, may be the result of chronic myelitis, as in the case of Count de Lordat; and similar cases are related by Portal, Ollivier, and Abercrombie.

Spinal Meningitis and Myelitis occasionally exist separately, either without the other; more commonly they coexist, but associated in very different degrees.

As the result of *railway collision*, only one case of *post-mortem* examination is recorded, where death had ensued from the secondary and remote effects of Concussion of the spinal cord; and whereby the symptoms observed during life were shown to be dependent on the pathological changes of structure which, from the history of this one completed case, are presumed to exist in other similar cases. The patient was under the care of Mr. Gore, of Bath, who, however, did not see him until about a year after the accident, and then at intervals up to the time of death. The case was that of a man, middle-aged, of active business habits, who having been in a railway collision, and without any sign of external injury—wound, bruise, fracture, or dislocation—began to manifest the usual nervous symptoms. He gradually, but very slowly, became partially paralyzed in the lower extremities, and died three years and a half after the accident. Dr. Lockhart Clarke carefully examined the spinal cord, which presented the inflammatory congestion of the meninges, effusion, softening, and atrophy, already described. More recently, a minute examination of the structural alterations consequent on concussion of the cord was made by Dr. H. Charlton Bastian. A man fell from the top of a hayrick, and had partial paraplegia, motory, but not sensory. He lived six months. The medulla oblongata and spinal cord were found to have undergone extensive granular degeneration. The important practical fact was, that in conjunction with such disorganization, the patient gradually recovered some power of voluntary motion in his limbs, and that sensation remained unimpaired to the last. This case is reported in the "Med.-Chir. Trans.," vol. l.

Symptoms.—Concussion of the Spinal cord is attended with, or followed by, symptoms of a paralytic character, which are essentially the same in all cases; but which vary in degree, according to the direct or indirect force of the concussion, and still more in proportion to the severity or comparatively slight intensity of the injury.

(*a.*) *Direct* and *severe* concussion is attended with immediate and marked symptoms. Pain at the seat of injury is felt, with loss of power in the extremities below that part, and there may be relaxation of the sphincters, the fæces and urine perhaps escaping involuntarily; and all these symptoms are accompanied with those of general Shock to the nervous system. The symptoms may pass off in the course of a few days, or result in complete paraplegia, of some months' duration or permanently irrecoverable.

(*b.*) *Direct* but *slight* concussion is followed by similar spinal symptoms, developed slowly and insidiously, in the course of several weeks or months; so that the causative relation between that comparatively slight injury and these apparently independent and serious symptoms subsequently, may seem improbable to the patient and to those who are unacquainted with such cases, and may be overlooked by the Surgeon.

(*c.*) *Indirect concussion*, from a *general Shock to the nervous system* or of the whole body.—Railway collision usually causes this mode of concussion; the carriage being brought suddenly to a stop, the traveller's body is carried forward by its own momentum, and dashed forwards against the opposite side of the carriage, thence perhaps to rebound back again. Or, without any contact from collision, the body may receive the shock, and the trunk be thrown backwards and forwards with a considerable concussion, in this way also wrenching and twisting the spine to and fro in the nature of a sprain. A fall or jump from a height, the individual alighting on his feet or his nates, may have a similar effect; general concussion involving the cord and spinal sprain.

The *symptoms* arising from this mode of concussion are often slow and insidious in their progress, weeks or months elapsing ere they assume a marked intensity. They relate to the brain, the spinal cord, and the limbs.

Immediately after a railway collision, an individual may suffer no apparent injury, beyond feeling generally shaken, and somewhat faint or confused; and this disturbance may soon pass off, leaving the person himself again, able to assist his seemingly less fortunate fellow-travellers, and having thus occupied himself for some hours, he proceeds on his journey. From that time, however, a general failure of nervous power is experienced, the sufferer feels that the spring and the go has been taken out of him bodily and mentally; he looks pallid, dejected, and older, broken in general health—a change which is more obvious in a person of previously active habits. His friends remark, and he feels, that "he is not the man he was." Trying, perhaps, from time to time, to resume his avocations, he is compelled to lay by, and with rest, getting better, he tries again, only to fail, until he is at length fairly knocked up. But some weeks or even months may elapse before more definite symptoms become developed. They correspond, it may be presumed, with the second stage; that wherein the primary effects of general concussion are succeeded by the symptoms of chronic inflammation of the membranes, and of the substance of the spinal cord, with similar affection of the brain. Mr. Erichsen has carefully analyzed the symptoms presented, of which the following is a summary; premising that while all the symptoms may be manifested in the same case, they are not necessarily associated.

Cerebral symptoms.—With a pallid, careworn *expression* of countenance, *pain*, giddiness, or some uneasy sensation in the head is complained of, or may be elicited by pressure on the crown, and by rotation of the head or movement backwards and forwards. The functions of the brain are defective or perverted. The *memory* is deficient, as with regard to dates, words, figures. The *thoughts* are confused, the patient being unable to combine his thoughts in argument or reading, so that the latter effort is abandoned after a few minutes' attempt to read a book or paper. As a consequence of this impairment of memory, and inability to concentrate ideas, all business aptitude is lost. The *temper* undergoes some change for the worse, a calm and cheerful disposition often becoming peevish and desponding. *Sleep* is exchanged for wakefulness, or disturbed by horrible and startling dreams. The *special senses* are variously impaired or perverted. *Vision* is defective, in regard to focal distance and clearness, so that letters of print or writing run into each other. Double vision and squint are occasionally met with. Intolerance of light is often complained of; and black spots, or flashes of light, are constantly seen. One or both eyes may be affected. *Hearing* may be over sensitive or dull; in the former state any sudden noise startles and distresses the patient. *Taste* and *smell* are more rarely defective or perverted. *Speech* generally remains unaffected; but stammering or mumbling occurs in some cases. *Touch* is often impaired, the patient being unable to pick up a pin, or button his dress; and the sense of weight is lost, a shilling or a sovereign on the point of the finger feeling of equal weight.

Spinal symptoms.—The *attitude* referable to the state of the spine is peculiarly erect and stiff, in consequence of the pain occasioned by flexion forwards, backwards, or sideways, or by any attempt to rotate the trunk. This pain restrains any movement involving the vertebral column, as in stooping, or rising from the recumbent position. The pain is elicited on examination, by pressure or percussion, in the course of the spinous process, or by the application of a hot sponge. At some one, two, or three points, sensibility will be found increased. These are commonly the mid-dorsal, the dorso-lumbar, and the cervical regions, extending over two or three vertebræ. Sometimes the pain extends laterally, on either side of the spine, apparently corresponding to the posterior branches of the spinal nerves. The pain, therefore, may be musculo-cutaneous, as well as deep-seated in the spine. A distressing sensation, as if a tight cord were round the waist, with hiccuppy breathing, is sometimes experienced.

The Limbs.—The *gait* of the patient is very characteristic; a straddling, shambling, and tottering walk, as if his legs were not his own. Exercise, therefore, becomes more and more limited; and movement up and down stairs difficult, especially the latter act. A stick is often had recourse to habitually, or the patient steadies himself by laying hold of any support in his way. This loose gait and rigid spinal attitude, the patient, with head erect, looking straight forwards, present the appearance of a man walking blindfolded. The *failure of nervous power* in the limbs is very variable in its extent and degree.. It may affect one or both legs, or the arm and leg on the same side, or one arm and both legs, or all four limbs may be more or less paralyzed. Motor power only, or sensation only, or both, may be lost, and in an equal or different degrees; but the paralysis is seldom complete. Partial paralysis is not uncommon; as in the extensor of the great toe, the flexors of the fingers, or the muscles of the ball of the thumb. Motor paralysis may be tested by the galvanic current, so as to excite the irritability of the same muscles in the opposite limbs. Loss of motor power in the hand can be estimated by the force of the patient's grasp, or more delicately by the dynamometer. The sphincters are rarely affected; frequent micturition being met with occasionally, retention of urine seldom, and involuntary defæcation perhaps never. Diminution or perversion of sensation comprises numbness, as shown by Brown-Séquard's instrument; coldness, perceptible to the touch, or shown by the thermometer; and various sensations of tingling, like pins and needles, burning and darting sensations. These feelings are often limited to a single nerve, as the ulnar or the musculo-spiral. Sexual desire and power are generally greatly impaired, or even entirely lost.

Nutrition fails, the muscles becoming wasted, and soft in some cases, with a diminution in the size of the limbs as shown by measurement; but a contracted and rigid state of certain muscles supervenes in some advanced cases, as affecting the deltoid, the little and ring fingers, the muscles of the calf, or the extensors of the great toe,—these muscular affections contrasting with the softened state of the muscles in general. The *pulse* varies in its character at different periods. At an early period it is usually slow; at a later and advanced period, it is quick, rising to 90 or 100. It is always feeble. This state of the pulse, especially its increased and increasing rapidity, is always a significant symptom.

Diagnosis.—Concussion of the spinal cord must be distinguished from other injuries and diseases. From *spinal sprain*, concussion differs in the presence of paralytic symptoms; unless the sprain be complicated by intra-vertebral hæmorrhage, or intra-vertebral suppuration as a consequence of inflammation, in either case causing compression of the cord. *Cerebral Concussion* is difficult to distinguish from concussion of the cord, the two being usually associated; and the precise diagnosis is unimportant. But the pain in parts of the spine, and its rigidity, are differential symptoms as to the seat of injury. From *rheumatism*, concussion of the cord differs in the presence of true paralytic symptoms, motor, sensory, or both, and the localized spinal pain; the progressive character of the symptoms, and the previous history of the case, as commencing from injury. The concomitant articular inflammation, and state of the urine, in regard to lithic acid and the deposit of lithates, are, on the other hand, symptomatic of rheumatism. *Hysteria*, as manifested through the spinal cord by hysterical paralysis, may simulate paralysis arising from concussion of the cord. But the history of the case, its progressive character also, and without any complete intermission of the symptoms, are clearly diagnostic; while the sex, age, and temperament of the patient, with the absence of other hysterical symptoms, may further contrast with hysteria,—which commonly occurs in females rather than males, in the young rather than in the middle-aged and old, in those of an excitable and emotional disposition rather than in the steady-going, working man of business, and in whom there are no other symptoms of hysterical affection.

Terminations, and *Prognosis.*—*Death* results from concussion of the spinal cord, in *most* cases, the issue of which has been known. But the *period* of the fatal result,—or the probable duration of life,—varies according to the severity of the injury. *Severe* and *direct* concussion of the cord, as from a heavy blow on the back, will probably have a speedily fatal termination; and the more so if accompanied with intra-vertebral hæmorrhage. *Indirect*, and perhaps severe concussion, as from Railway collision, in most cases, which is commonly followed by paralytic symptoms slowly and progressively developed, terminates fatally in a period varying from two and a half to five years; or perhaps at a much later period,—fifteen or twenty years. When death does not ensue, *recovery* may take place, more or less completely, according to the stage of the case after concussion of the cord. The *primary*, and almost immediate, paralytic symptoms may pass off, and more probably so in proportion to their immediate severity, especially if the patient be young and healthy; recovery taking place completely and permanently. A period of six months, under treatment, will perhaps suffice to entirely reinstate the health. The *secondary* and subsequent paralysis, from softening of the cord, consequent on Meningo-myelitis, may terminate in partial recovery; but complete restoration from this structural change is impossible.

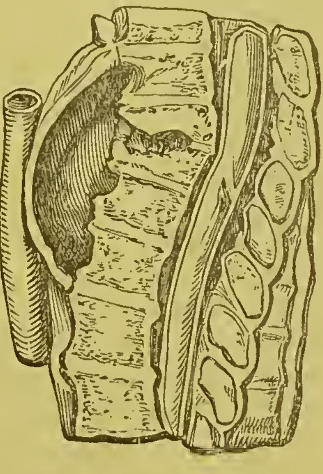
The *Prognosis* of concussion of the spinal cord must be regulated by the foregoing considerations.

I have entered more fully into the nature of this injury of the cord, on account of its great practical importance, and as being a subject of frequent Medico-legal inquiry; in not a few cases of which I have been engaged.

Treatment.—Rest, absolute rest, is essential to any probability of recovery from spinal concussion or wrench. The patient should keep the recumbent position, or a prone couch may be used, until the paralytic symptoms have disappeared; and especially until the limbs have regained the power of voluntary motion, and sensibility. A prone couch offers the advantages of preventing venous congestion of the spine, as the result of long-continued recumbency; any tendency to sloughing from pressure over the sacrum and nates, the liability to which is always greater in paraplegia, will also be prevented; and the prone position readily allows of any local treatment. Rest of the brain is equally essential to recovery; freedom from the excitement of business or pleasure, which, although apparently beneficial for a time, is permanently conducive to a fatal issue. *Local* treatment consists in derivation from the spinal cord, by means of dry-cupping along the spine on either side; followed by counter-irritation, by blisters, setons, issues, or even by the actual cautery, in the form of the moxa. *Constitutional* treatment comprises the continued administration of gentle mercurials, especially the bichloride, or iodide of potassium, with quinine, as a tonic. Subsequently, when all inflammatory action has subsided, and paralysis of motion, sensation, or both, alone remains, with a cachectic state of the health, strychnine and iron will prove efficacious. A sixteenth or twelfth of a grain of strychnine, with three or four grains of the sulphate or phosphate of iron, in the form of a pill, three times a day, may be continued with advantage until slight tetanic twitchings are induced. In conjunction with strychnine, the galvanic current should be employed; one pole of the battery being placed in the course of the spine, while the other is applied up and down the paralytic limbs, so as to excite the action of different sets of muscles. Salt-water douches, and frictions, may also have some beneficial influence. The general health and strength must be supported and renovated by a nourishing diet, and other hygienic measures. I have seen the best remedial results from this course of treatment, in many cases.

COMPRESSION OF THE SPINAL CORD.—This injury to the cord may depend on either of three causes, or perhaps their concurrent action: intra-vertebral hæmorrhage; intra-vertebral suppuration or abscess; and fracture of the spine, with displacement. The two former causes of compression must severally be treated on general principles; the latter is noticed under fracture of the spine. Obviously, however, no source of compression affecting the spinal cord, can be readily amenable to treatment.

FIG. 730.*



DISEASE OF THE SPINE.—*Structural Conditions.*—The generic term, disease of the spine, as ordinarily understood, signifies *caries* of the vertebræ, apparently of a scrofulous character; which commences probably in the *bodies* of these bones, and involves the inter-vertebral fibro-cartilages. (Fig. 730.) This disease is situated, usually, in the bodies of the *mid-dorsal* vertebræ; but extending upwards and downwards to several vertebræ, the upper or lower dorsal, or even the upper lumbar vertebræ and fibro-cartilages, may be diseased. The bodies of the affected vertebræ become disintegrated, and the cartilages destroyed; the spine yields under the superincumbent weight of the trunk, and gradually bending forwards forms an "angular curvature," commonly known as "hump-back"—a prominence of the spinous processes of the

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* St. Thomas's Hosp. Mus., E. 7. Commencing caries in the bodies of dorsal vertebræ, sixth and seventh, with destruction also of the inter-vertebral cartilage. The anterior common ligament is separated to some extent above and below the seat of caries, by the formation of abscess.

FIG. 731.*

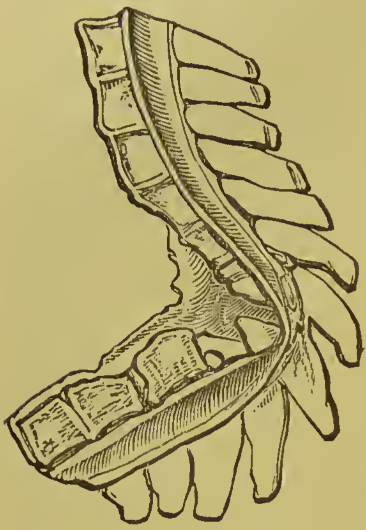
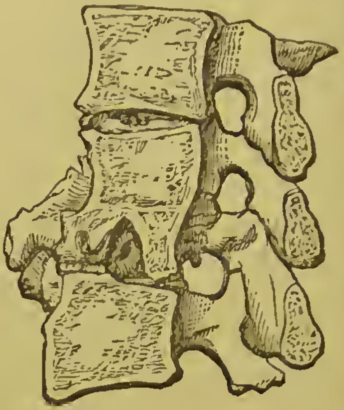


FIG. 732.†



vertebræ posteriorly at the seat of curvature. (Fig. 731.) When, in rare cases, caries is restricted to a central portion of the body of a vertebra (Fig. 732), the spinal column retains its normal shape,—there is no excurvation.

The *spinal column* occupying the middle line of the body and being equally balanced laterally, it bends forward in that line without lateral deviation. Some such inclination is apt to take place, to one side or the other, only in the dorso-lumbar and lumbar regions, where the spine has the greatest latitude of motion. At first also, the degree of angular deformity backwards corresponds to and represents the amount of destruction of the bodies of the vertebræ. But the human figure—unlike the permanent direction of an inclining column of brickwork, or other dead weight, yielding in the middle—has some compensatory power of gradually restoring itself to the perpendicular; thereby correcting any irregularity in the line of gravity. The spinal column is, in fact, a flexible pillar of support, and subject to the action of muscles. Accordingly, as Mr. Shaw observes, a person with angular curvature of recent occurrence, and tending, therefore, to tumble head foremost, gradually regains the line of gravity. Habitually throwing the head and shoulders backward, he walks as if with an air of pride; so that the angular excurvation ultimately becomes combined with two incurvations, one above, and the other below, in contrary directions; the whole spine assuming an appearance, in profile, not unlike a double bracket ({). If angular curvature takes place at the very base of the spinal column, thus allowing the whole trunk to incline forward, any such restoration of equilibrium will be impossible; and the patient gropes along with the body horizontal to the legs. The *thorax* falling down, with the spine above the point of curvature, becomes shut up, as it were; the ribs being compressed, and the sternum projecting, or sometimes bent at an obtuse angle as a sort of counterpoise to the posterior protuberance. The shape of the thorax is altered, its antero-posterior diameter being increased and the vertical decreased. This shortening of the trunk gives a pot-bellied appearance to the abdomen; the whole trunk seeming to have fallen down in a lump. (Fig. 733.) The viscera, thoracic and abdominal, also undergo compression; but, accommodating themselves to their respective cavities, they do not suffer apparently in their structure or functions. The aorta, still following the course of the spine, bends with it at the seat of curvature. Rarely is the spinal cord compressed or otherwise injured (Fig. 734); sometimes, it becomes softened at the angle of curvature, and paralysis of the parts supplied below ensues.

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* St. Thomas's Hosp. Mus., E. 9. Carious destruction of the bodies of several dorsal vertebræ; with angular curvature of the spine, posteriorly. From a girl, aged fifteen; duration of carvature, two years.

† Ibid., E. 35. Central caries of the body of a vertebra, fourth lumbar, with reparative deposit of bone under the anterior common ligament, resulting in anchylosis of the adjoining vertebræ. Owing to the situation of the carious destruction, the body of the affected vertebra remains supported, and no angular curvature of the spine has taken place.

FIG. 733.*

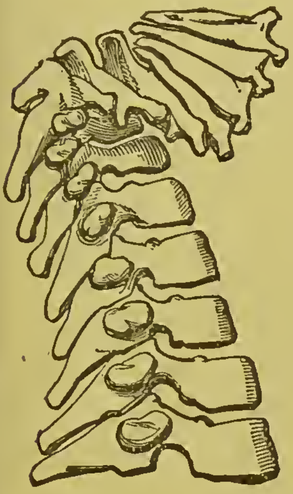
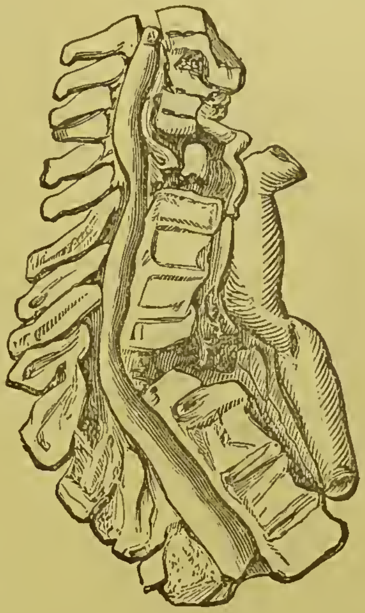


FIG. 734.†



Signs and Symptoms; and Diagnosis.—Disease of the spine commences with a sense of weakness in the back; the patient feels some inability to stand upright, and, leaning forwards, rests his hands on his knees, or avails himself of any other temporary support. This sign is never absent, and it is rendered equivocal only by its connection also with hysteria affecting the spine. A slight *prominence* soon appears in some portion of the spine, usually in the dorsal region, and this point is tender or painful when pressed or tapped with the fingers; the patient wincing when pressure falls on it in passing down the line of the spinal column. But pain is a very inexact symptom. It may be entirely absent with marked angular deformity; and present, severely and persistently, in a particular spot without spinal disease, as in some cases of hysteria. *Rigidity* of the spine is, however, an equally early and exact sign with falling weakness and angular deformity. It is readily perceived by desiring the patient to stoop and raise himself alternately, or by then placing the hand on the suspected vertebræ; the spinous processes will be seen and felt to move unitedly as a connected mass. This loss of separate mobility is said to arise from the adhesive solidification around the arches of the vertebræ, forming a compensatory support, while the bodies are destroyed by carious disintegration. Symptoms referable to the *spinal cord* supervene; shooting pains extend round the trunk or down the limbs; and the patient has a tottering, sprawling gait, with spasmodic affections of the muscles of the lower extremities, or relaxation of the sphincter ani, retention of urine, or other paralytic symptoms. The angular deformity of the spine has now become well marked, and is rendered more conspicuous by wasting of the muscles in the trough on either side of the spinal column. The excurved ridge of transverse processes stands out like a keel (Fig. 735), with a serrated edge, the tubercle of each process being distinctly visible. The transverse and oblique processes can also be distinguished.

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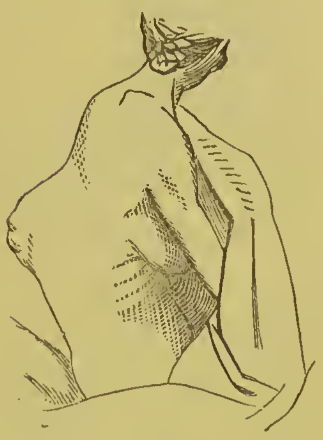
* St. Thomas's Hosp. Mus., E. 31^1.

§ Ibid., E. 6. Double caries, or in two parts, of the spinal column; in the cervico-dorsal region, and in the mid-dorsal region. In the upper seat of disease, the bodies of the last four cervical and those of the upper two dorsal vertebræ, with their inter-vertebral cartilages, are more or less destroyed. In the lower gap, the whole body of the sixth and part of the fifth and seventh dorsal vertebræ have been destroyed. Abscess has formed in both seats of disease, under the anterior common ligament: there is more or less double angular curvature, and compression of the spinal cord. The aorta corresponds to the displacement of the column. Ossific union of several of the dorsal spines seems to resist any further excurvation.

FIG. 735.*



Spinal hysteria—occasionally resembling disease of the spine, with regard to the pain, as above noticed—may generally be diagnosed by certain differential characters. The pain is severe, but superficial, and not limited to one portion of the spine; aggravated by gentle pressure on the skin, rather than by deeper pressure on the bony processes, this pain is apt to shift its position, from the dorsal to the lumbar region, or up to the neck. With this spinal condition, paralytic symptoms are sometimes associated; loss of power in the lower extremities or paraplegia, and difficulty of, not in, voiding the urine. But the constitutional condition remains good, or unlike that which accompanies paralysis from disease or injury of the spine. The sex of the patient—a female; the age—probably youth; and possibly some uterine disorder—not disease, may supply additional diagnostic distinctions.

Pus forms in connection with caries of the vertebræ; at a more or less early period, and more or less abundantly, in proportion to the tuberculous character of the disease. The pain and paralytic symptoms—referable to the spinal cord—are relieved for a while, by suppuration. But it is only as a presenting abscess that the formation of matter becomes clearly available as a symptom of disease of the spine. This event—the appearance of an abscess—will depend on the progress of spinal disease, as described in connection with its *course*.

Causes.—The scrofulous constitution is probably always predominantly influential as a predisposing cause, leading to a deposit of tuberculous matter in the bodies of the vertebræ, which seems to be the exciting cause of carious disintegration. It is thus distinguished from the erosion produced by pressure, as of an aneurism; the osseous texture itself being quite firm, and free from any interstitial deposit. (Fig. 736.) No less distinctive is the destruction resulting from cancerous deposit, which is restricted to the bodies of the vertebræ.

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* Royal Free Hospital. (Author.)

Fig. 736.*

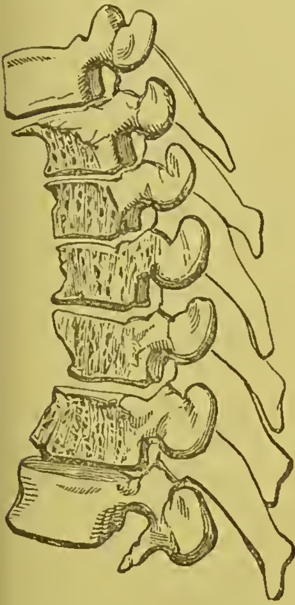


Fig. 737.†

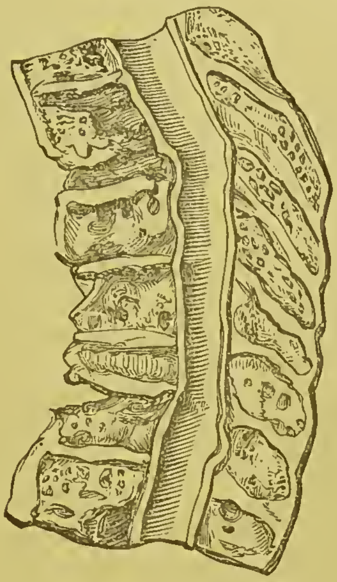
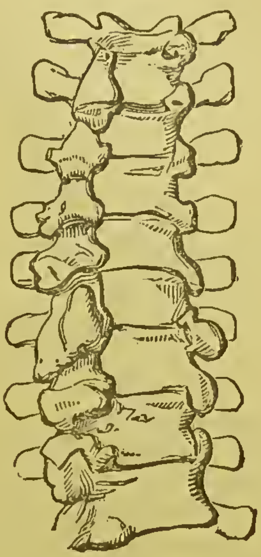


Fig. 738.‡



(Fig. 737.) Some slight injury to the spine may give rise to carious disease,—fixing the date to which it would appear referable.

Any period of life is liable to caries of the spine. Beyond middle life it is very rare; in childhood and adolescence, most common. It is met with equally in both sexes.

Course and Terminations.—*Abscess* results from the continued formation of matter. It may undergo *resolution*, the matter being slowly absorbed. In this way a large proportion of patients pass through the whole course of spinal disease, even to paraplegia, and regain their general health, without any signs of abscess in connection with the vertebræ having appeared. A process of restoration goes on also in the vertebræ. Carious disintegration and absorption are followed by bony deposit between the bodies, in the place of inter-vertebral fibro-cartilages, thus fusing and consolidating the bones into one mass; while bridges of bone are thrown out from body to body, forming additional buttresses of support to the spinal column. Similar bony outgrowths may be the result of chronic rheumatic arthritis (Fig. 738); but this condition is then unaccompanied by any destruction of the bodies of the vertebræ, and consequent deformity of the spinal column. This *anchylosis* is the natural cure of disease of the spine,—a not uncommon event, especially when aided by proper treatment; the patient, however, remaining deformed. (Fig. 739.)

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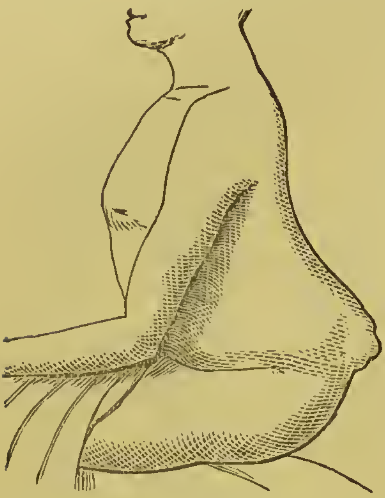
* St. Thomas's Hosp. Mus., E^1.

† Ibid., E. 45.

‡ Ibid., E. 38. Bony outgrowths on either side of the bodies of the vertebræ,—the lower eight dorsal and first lumbar, and situated just in front of the costo-vertebral articulations. Each outgrowth springs from the adjoining edges of two vertebræ, and seems to depend on ossification of the radiating costo-vertebral ligaments, but forming an arch over the inter-vertebral cartilage. Thus, each such arch consists of two pieces, the line of separation being distinct, or they have become fused together. These bony outgrowths are larger and more extensive on the right side.

Fig. 739.*



In a case of angular curvature, at the junction of the last dorsal and upper lumbar vertebræ, and of two years and a half duration from the symptom of falling weakness, I succeeded in inducing anchylosis by the recumbent position continued for nine weeks, when the patient had sufficiently recovered to take gentle walking exercise. After the lapse of nine months, he could walk ten miles a day, and has since become a hansom cab-driver,—bearing the constant pull of the reins without any return of the spinal disease.

Presenting abscess represents the unfavourable course of spinal disease, as implying the continued formation of matter and destruction of the spinal column. The abscess presents or makes its appearance in a variable *period;*—early, with weakness of the spine and before any deformity; or at a later period, after months or perhaps years. It appears in various *situations;* according to which, abscesses connected with spinal disease are nominally distinguished, irrespective of the particular parts of the column whence they arise. The route of any such abscess, "by translation," is often very devious and extensive.

Psoas abscess is the most common, and typical. The matter arising from the dorsal or the lumbar vertebræ, enters the sheath and substance of the psoas muscle,—passing in the former case through the diaphragm near the ligamentum arcuatum. Following the line of the muscle, the matter descends obliquely outwards, and passing under Poupart's ligament, appears in the groin; where, by extending upon the thigh, it may burrow to the knee, as a large and increasing femoral abscess. A *double* psoas abscess forms occasionally; the collection of matter at the spine bifurcates, and passing down within the sheaths of both psoas muscles, emerges in both thighs.

The *symptoms* of psoas abscess, as regards its connection with disease of the spine, are somewhat equivocal. The presence of an abscess may be detected in the groin, or even in the iliac region, by the usual symptoms;—a fluid and fluctuating swelling, which is partially emptied of its contents when the patient lies in the recumbent position, and which yields a fluctuation to and fro on careful palpation with one hand placed over the iliac fossa and the other over the swelling in the groin. But the communicating channel—under Poupart's ligament—may contract, whereby the abscess in the thigh becomes circumscribed and isolated; as if it were a distinct chronic abscess, connected with diseased femur, instead of proceeding from the spine.

Diagnosis.—The *origin* of abscess in the groin is various. It may proceed:—(1) from bubo or glandular abscess; (2) from disease of the hip-joint; (3) from iliac abscess, connected with disease of the iliac bone, or forming in the fossa; (4) from pericæcal abscess, on the right side only; (5) from perinephritic abscess; (6) from empyema, perforating the pleura and descending behind the diaphragm. The diagnosis of *abscess*, thus agreeing in situation, but differing widely in origin, will be guided by the *association* of *other* symptoms; the presence of other symptoms of spinal disease, or those of one of the diseases above named. Thus, when accompanied with weakness and slight excurvation of the spine, abscess in the groin would indicate this disease; whereas, with the present or past association of a chancre, or of shortening of the limb on the side affected, such an abscess would either denote its syphilitic origin, or refer probably to disease of the hip-joint. Compared with other tumours in the groin or iliac fossa, abscess, in these situations, differs more or less in its *own* characters. Thus, from *fatty tumour* in the groin, abscess differs in its fluid and fluctuating character and partial subsidence in the recumbent position, as compared with the solid doughy consistence and irreducibility of a fatty mass. *Femoral hernia* is distinguished chiefly by the perceptible impulse on coughing, and gurgling character of the swelling.

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* Royal Free Hospital. Disease, and excurvation, of lumbar vertebræ. (Author.)

The *progress* of psoas abscess is mostly unfavourable. The resolution of an internal abscess, which has already enlarged so far as to become apparent, is a rare event. Slowly perhaps, but surely increasing, the abscess at length bursts. The general health will then inevitably undergo a great change. From a comparatively local state of disease,—the patient carrying about a large indolent abscess in his thigh, constitutional disturbance now supervenes, in perhaps a day or two, or a week or two. Hectic fever, with great emaciation, follows, large bed-sores form, and the patient dies exhausted.

Other Varieties of Spinal Abscess.—The different *situations* in which spinal abscess may make its *appearance* are specially worthy of notice.

Psoas abscess emerges from under Poupart's ligament, in the narrow interval between the united bellies of the psoas and iliacus muscles and the anterior inferior spinous process of the ilium; its progress is arrested by the origins of the sartorius and tensor vaginæ femoris muscles, which incline it inwards obliquely across the thigh, in the line of the sartorius. But the abscess may turn abruptly inward or outward, at the groin; or coursing downwards, divide into two portions, an inner and an outer; or burrow under the muscles of the thigh, into the popliteal space, or pass thence on to the calf or ankle. Sometimes, this abscess descends into the subperitoneal tissue of the pelvis, and presents along the rectum at the anus, or emerges from the sciatic notch and passes down by the side of the trochanter.

Lumbar abscess is perhaps the next in order of frequency after psoas abscess. The matter passes directly backwards, chiefly by perforating the quadratus lumborum muscle, and forms a rounded broad flattened abscess. Its boundaries usually are the lowest rib above, the crest of the ilium below, the sacra-lumbalis internally, and the margin of the external abdominal oblique muscle externally. This abscess frequently coexists with psoas abscess. The matter may come from the lumbar or dorsal vertebræ, having descended from the latter.

Dorsal abscess sometimes forms, by the passage of matter directly backwards. Or matter, proceeding from the dorsal vertebræ, passes down under the pillars of the diaphragm along the aorta and iliac vessels, into the iliac fossa, and comes forward through the anterior wall of the abdomen above Poupart's ligament; or, sinking into the pelvis, it escapes through the sacro-sciatic notch, and collects in the *gluteal* region.

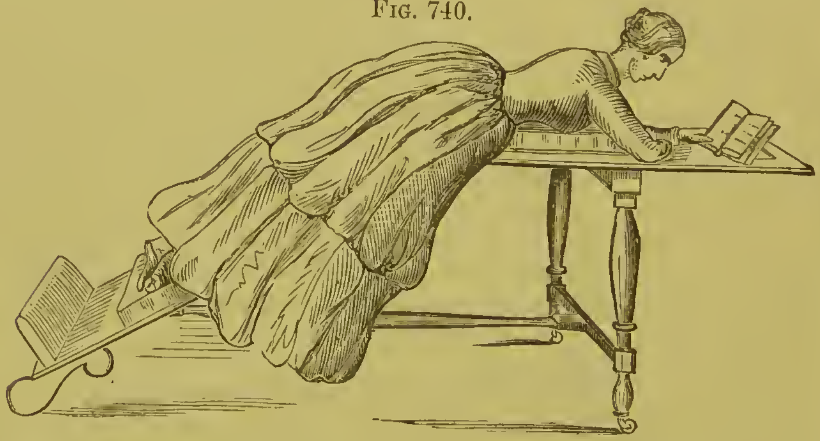
Disease of the cervical vertebræ exhibits equally remarkable varieties of abscess in respect to the situations of its appearance. The matter coming forwards, it presents behind the *pharynx*, or may descend under the sterno-mastoid muscle to the side of the *neck;* occasionally, it passes down into the thorax, or into the *axilla.*

The pathology of all these varieties of abscess connected with spinal disease is essentially the same as that of psoas abscess. Any such abscess is liable to attain a considerable, even an enormous, size; it bursts, and discharges at intervals or continuously; hectic, or a typhoid type of fever supervening, and a fatal termination.

PROGNOSIS.—The *prognosis* in caries of the spine is always precarious. A favourable prognosis has reference only to anchylosis, the patient remaining hump-backed for life. But this angular deformity and anchylosis have a mutual relation; the remnant bodies of the vertebræ becoming united by the falling down of the column. Angular deformity, therefore, usually indicates a more satisfactory result, life being preserved; whereas, the spine remaining straight is ominous of a fatal issue. For then the spinal cord is exposed; paralytic symptoms become aggravated, and abscess increasing by progressive caries of the vertebræ, at length bursts, and leads almost inevitably to the overwhelming constitutional disturbance already noticed, hectic and exhaustion.

TREATMENT.—Guided by the natural mode of cure—anchylosis—the primary indication of treatment is to bring about this result. Hence, absolute rest in the horizontal position must be observed, in order to prevent any motion affecting the vertebræ, and to relieve the weight of the trunk from the spinal column. A prone couch (Fig. 740), the patient lying on her belly, answers this purpose best. It should be constructed so as to admit of being raised to a varying angle with the floor, and thus render the position more tolerable than an absolutely horizontal posture. The prone position of the patient is preferable to the recumbent, as the angular prominence of the spine escapes compression and any tendency to congestion affecting the diseased ver-

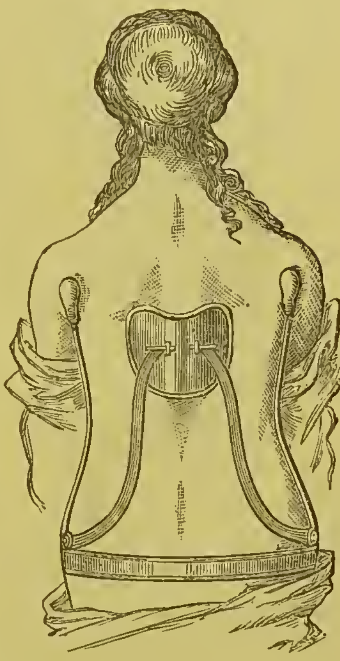
FIG. 740.



tebræ; both of which evils would result from a long-continued resting of the patient on her back. In this way the progress of the disease may be arrested without further measures. Blisters, setons, moxæ, are sometimes useful adjuncts, as means of counter-irritation; but they more commonly prove obnoxious by disturbing sleep, and enfeebling by giving rise to a draining discharge. Should these appliances be resorted to, the prone position will obviously be more convenient, as well as being otherwise advisable. This plan of treatment having been pursued for six months, a year, or more, according to the state of the disease, some degree of freedom may then be allowed to the patient by wearing an apparatus to support the trunk.

It consists of a broad pelvic band, as the basis, from which two steel rods, one on either side of the trunk, pass upwards, terminating in padded crutches for the arm-pits. A back-plate is added for the direct support of the spine at the seat of curvature. (Fig. 741.)

Fig. 741.



Throughout the whole course of the disease, medical treatment should have regard to the improvement of nutrition. Hence tonics, of which iron and quinine are most efficacious, with cod-liver oil, and a generally nutritious diet, will aid the effect of rest in procuring anchylosis. Intercurrent paralytic symptoms mostly subside, when the disease thus progresses favourably; the spinal cord recovering its functional power. Small doses of bichloride of mercury, from the twentieth to the sixteenth of a grain, may be given with advantage, as recommended by Stanley.

Psoas abscess, or abscess in any other situation, resulting from spinal disease, requires no special treatment. Like any other large indolent abscess, no interference is necessary, until it threatens to burst. A small valvular opening should then be made, to relieve tension without the admission of air; and closed, before the matter has ceased to flow, with a pad of lint and a strip or two of plaster. This procedure may be repeated from time to time, as occasion requires. If the carious disease of the vertebræ be arrested, matter ceases to accumulate; and the abscess contracting with each evacuation, its cavity will at length become closed.

Treatment by Suspension and Plaster of Paris Bandage.—A new method of treating cases of Pott's disease of the spine by suspension and use of the plaster of Paris bandage was introduced into this country by Professor Sayre, of New York, in the year 1877; but he had carried out this practice in America three years previously. The mode of applying the plaster of Paris jacket, and the result of treatment, are described in a work recently published.*

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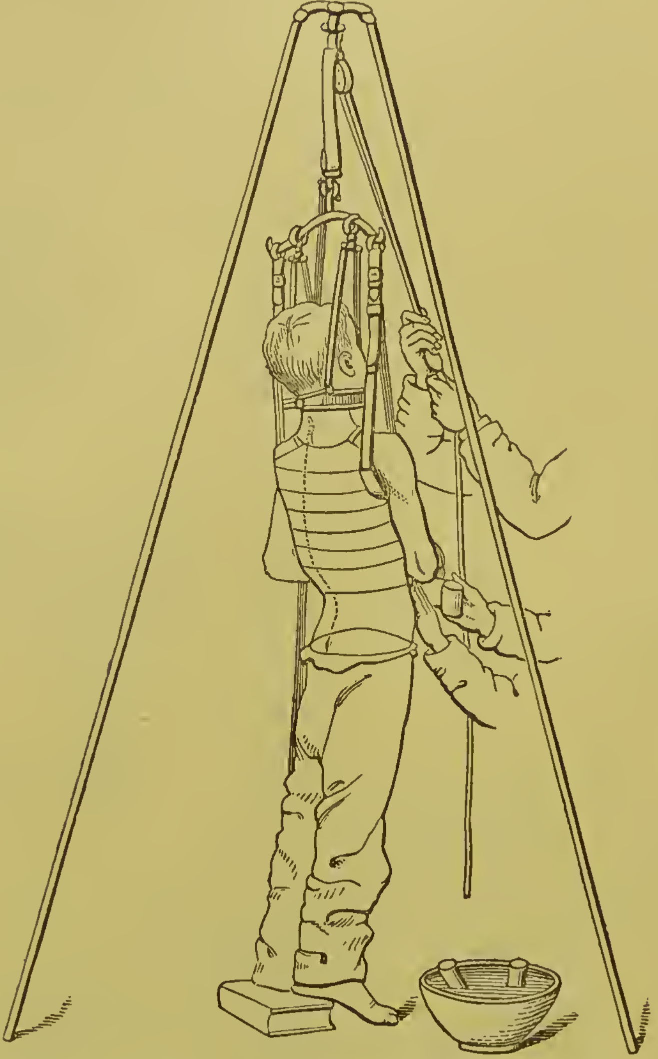
* "Spinal Disease and Spinal Curvature: Their Treatment by Suspension and the Use of the Plaster of Paris Bandage," by Louis A. Sayre, M.D., of New York. Smith, Elder & Co., London. 1877.

The general idea of this method of treatment is to straighten the spine, by suspension, to a sufficient extent to remove pressure from the bodies of the diseased vertebræ, and, whilst the spine is thus straightened, to encase the body in an accurately fitting plaster of Paris jacket (Fig. 742), so as to preserve the improvement gained by suspension, and secure perfect immobility and rest to the diseased spine; whilst the patient, thus supported, is enabled at once to walk about, and take exercise in the open air—a method of treatment which contrasts strongly with that by which rest to the spine is secured by long-continued recumbency.

FIG. 742.



When the disease attacks the upper dorsal or the cervical vertebræ, an addition to the plaster of Paris jacket is made by carrying a light steel support over the head, which is suspended by straps passing under the chin,—an apparatus described by Dr. Sayre as a jury-mast. These plaster of Paris jackets require to be renewed at intervals varying from one to two months.

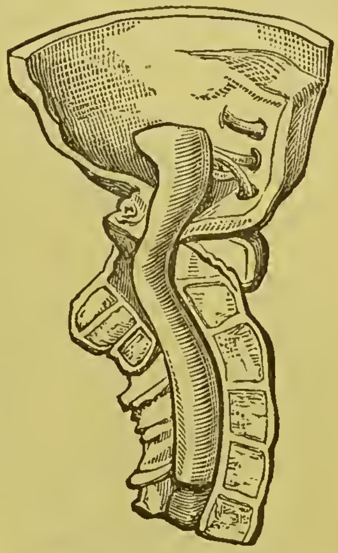
The results of this new American method of treatment appear to be extremely satisfactory, so far as ascertained up to the present time,

* Royal Free Hospital. Sayre's treatment of spinal disease. (Author.)

and no evil results have followed the suspension principle; excepting, in some instances, the production of sores, either from pressure when the plaster of Paris bandage has been applied over sharp prominences without the protection of lateral padding, or in other cases sores produced by friction when the jacket has become too loose. In either case a reapplication of the jacket is necessary. (Note by William Adams.)

DISEASE OF THE ATLAS AND AXIS, AND OF THE ATLAS AND OCCIPITAL BONE.—Caries of the first two cervical vertebræ is less liable to occur, there being less osseous substance than in other vertebræ. Disease begins in their articulations, or in the occipito-atloidean articulations; thus resembling disease of other joints. Swelling and pain, with rigidity or inability to move the head, are followed by abscess behind the pharynx. A broad fluctuating swelling in this situation, extends to either side of the neck, giving the individual a remarkable appearance, grotesque if it were not distressing. Deglutition, respiration, and speech are impaired, the voice having a nasal twang; while with an anxious expression, open mouth, and dribbling saliva, the head fixed and supported by both hands under the chin, the patient turns round bodily in looking at anything, and the eyes acquire a peculiar rolling range of motion. Wasting hectic may gradually reduce the sufferer; or his misery terminate suddenly by asphyxia, owing to pressure on the cord by dislocation of the axis forwards, the transverse and accessory check ligaments having given way. The head falls forward, carrying with it the atlas, the odontoid process of the axis compresses the cord, and all is over. (Fig. 743.)

FIG. 743.*



It is said that the atlas may undergo dislocation *gradually*, and even so far forward as to bisect the vertebral canal into equal parts, thus compressing the cord into half its former size, yet without paraplegia resulting. The patient may, indeed, recover, with permanent dislocation and anchylosis. Certain slight defects only will then be observable; a stiff and somewhat contorted neck, the chin and face advanced unnaturally, and the back of the head more in a line with the spine, while the spinous process of the axis projects conspicuously.

The *cause* of this disease would appear to be a scrofulous constitution, provoked probably by some slight strain or other injury affecting the neck. Puberty seems to be the age at which the disease commonly begins; but it occurs also in infantile or adult life.

Treatment must be the same in principle as that of spinal disease producing angular curvature; absolute rest by fixing the head, counter-irritation when necessary, and tonics.

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* St. Thomas's Hosp. Mus., E. 2^1. Absorption of the odontoid process of the axis, with dislocation backwards of the body of that vertebra. There was no trace of pus, and the parts seemed to be undergoing repair; tolerably firm cellular adhesions uniting the anterior surface of the body of the axis with the under border of the atlas. The spinal canal is here much diminished, and the cord has suffered compression. From the body of a man, aged twenty-eight. No history recorded.

Lateral Curvature of the Spine.—*Structural Conditions.*—Spinal Curvature may take place laterally, to one side or the other, and with another or compensating curve to the opposite side; thus presenting a very different appearance from angular curvature forward, with a sharp projection backwards. Lateral curvature usually forms in the middle of the back—mid-dorsal region of the spine—and with its convexity towards the right side; the second curve is in the lumbar region, and its convexity towards the left. This curve arises nearly simultaneously with the first curve, constituting *double* lateral curvature. (Fig. 744.) Sometimes four curves occur; namely, besides a dorsal and a lumbar, a cervical and a lower lumbar curve are produced, also in opposite directions. There will then be two curves to one side, and two to the other, arranged alternately; the whole spine having a quadruple undulatory form. The effect of this double and opposite curvation, whether in one or two pairs, is to bring the weight of the trunk over the sacrum, as the base of support, and thus maintain the balance of the body. Another and a remarkable change takes place, concurrently with lateral curvature of the spine. In each such curve, the aberrant vertebræ twist or undergo rotation, to some extent; so that the anterior faces of their bodies look towards the convexity of the curve, the spinous processes towards the concavity. (Fig. 745.) A double kind of curvature, *lateral* and *rotatory*, is the resulting structural

Fig. 744.

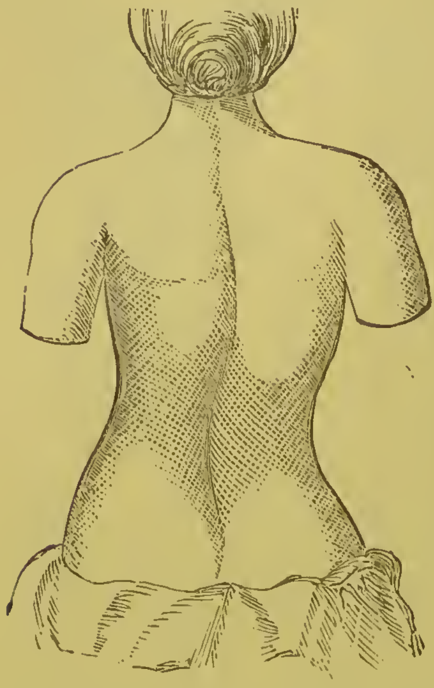
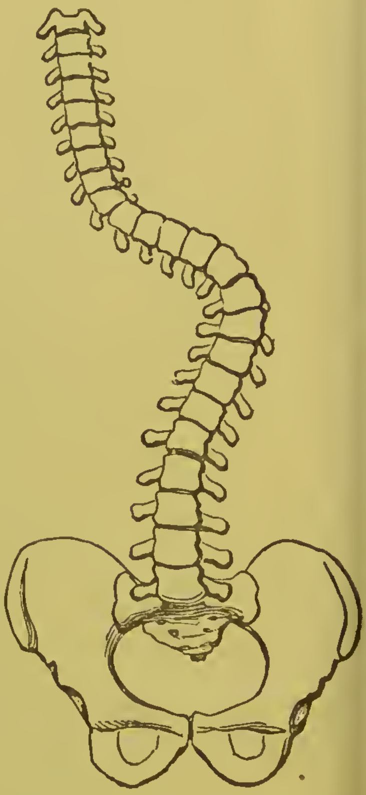


Fig. 745.*



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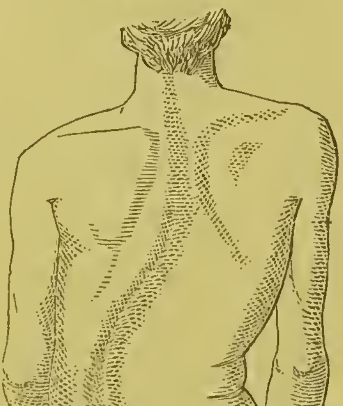
* St. Thomas's Hosp. Mus., E. 60. Lateral curvature of the spine, in the upper dorsal region, the convexity towards the right side; and, in the lower dorsal region, a compensatory curve, in which the anterior parts of the bodies of the vertebræ have undergone rotation forwards towards the left. The sacrum is somewhat higher and posterior on the left side, as compared with the right. A slight incurvation of the anterior spinous processes of the ilium has also taken place,—not recognized in the figure.

alteration of the vertebral column. The *bodies* of the *vertebræ* become somewhat compressed in the concavity of either curve; but there is no apparent disease of the osseous structure. The *inter-vertebral cartilages* undergo compression, so as to acquire a wedge shape, the thin portion corresponding to the concavity of the curve; and this alteration of form is proportionate to the degree of curvature. The *ligaments* are simply stretched and somewhat relaxed. The *ribs* conform to the direction of the dorsal curvature; being thrown outwards and upwards on the convexity of the curve—towards the right side, and drawn inwards and downwards, at its concavity—towards the left side. The *thorax*, therefore, bulges on the one side and is depressed on the other. The *pelvis* also conforms to the lumbar curve; it is raised, accordingly, on the side of concavity—the right, and lowered on the side of convexity—the left. Rotation, or the twist of the spine, produces peculiar changes; the thorax projecting backwards somewhat, as well as outwards and upwards, on the right side; and the pelvis backwards, as well as downwards, on the left side.

Signs, and Diagnosis.—The signs of lateral curvature are obvious, and correspond to the structural alterations of conformation above described. On tracing the spinal column from above downwards, by passing the finger along the tips of the *spinous processes*, some unnatural curvature of the *dorsal* spine to the one side may be perceived, with a compensating curvature in the *lumbar* region to the other side. And this line of undulation will be rendered more visible by marking it with a pen dipped in ink. But the degree of rotatory displacement cannot be determined by the line of the spinous processes. The tips of these processes—which, until there is considerable displacement, are the only portions of the bones we can feel—are those very parts which in rotation move most away from the side to which lateral displacement tends; thereby allowing considerable displacement of the vertebræ, while the spinous processes still lie in a straight, continuous line. *Bulging of the thorax*, beneath and outside the *angle of the scapula*, is an early sign; and followed by projection of this bone—"growing out" of the blade bone, at a later period, with some elevation of the shoulder. This corresponds to, and denotes, the *dorsal* curve. (Fig. 746.) A posterior projection of the *innominate bone*, marked by a protuberance backward just outside the *sacro-iliac joint*, is also an early sign; and followed by lateral projection of the *hip*, altering the outline of the figure, at a later period. This corresponds to, and denotes, the *lumbar* curve. The priority of a prominent shoulder, or of a prominent hip, denotes a curve primarily dorsal or primarily lumbar.

Fig. 746.*



The *front of the chest* exhibits certain opposite alterations of configuration as compared with its posterior aspect. The right side appears small and depressed, the left prominent. Slighter changes of form can be detected, and the diagnosis confirmed, by an instrument designated the "rotation-measurer."

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* Royal Free Hospital. (Author.)

A primarily dorsal curve presents certain varieties, depending on its causes or mode of production, and which are of practical consequence.

The *weight-bearing curve*—in Mr. Barwell's experience—is uniformly the same; it occupies the upper three-fourths of the dorsal region, and the compensatory lumbar curve commences with the lower fourth vertebra. A perpendicular line, from the last cervical vertebra to the middle of the sacrum, crosses the double curve once, at the ninth dorsal vertebræ. The most aberrant vertebræ are the fifth dorsal to one side, the second lumbar to the other. A well-marked *vertical rounded eminence* of muscular contraction runs upward from the back part of the ilium to the most aberrant vertebræ.

The *respiratory curve* varies with its origin; namely, some external cause restraining abnominal respiration, or some internal and pulmonary disease. This curve much resembles that produced by weight-bearing; but the vertical line of muscular development is absent, and the second curve is proportionately less. Curves of *internal* origin assume a variety of shapes; a short and sharp curve, particularly if high up, will probably be the consumptive curvature; a longer curve, high up, results probably from pleurisy; and a long curve, low down, proceeds mostly from pneumonia. The situation and form of these dorsal curves will, therefore, materially determine the diagnosis of lateral curvature having a respiratory origin.

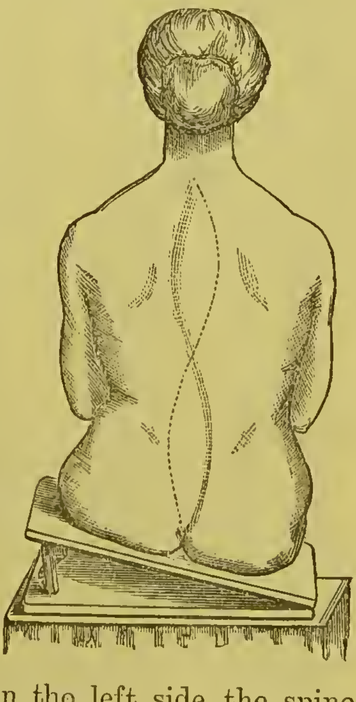
Both kinds of dorsal curvature—weight-bearing and respiratory—lie to the *right* side, generally; but as respiratory curves are invariably so, excepting in lung disease or the rare instance of visceral transposition, any primarily dorsal curve to the *left* will be weight-bearing.

Causes.—*Age* has an immediate relation to lateral curvature of the spine; this deformity taking place mostly about the age of puberty, and in girls. It would seem that at that period of life, and in the female sex more particularly, the bust and shoulders undergo development, and become more weighty than in proportion to the supporting stability of the vertebral column and its ligamentous connections. This naturally increased weightiness of the thorax may be augmented by certain *occupations*, as that of nurse-girls by carrying an infant constantly on one arm. Or again, the erector muscles of the spine, in common with the whole muscular system, may be in an atonic and weakened state, relatively to the increasing weight thrown upon them by the development of the trunk; and this *muscular weakness* is more liable to occur in females as a result of the anæmia of disordered menstruation. Certain occupations which compel an habitual one-sidedness of posture, provoke lateral curvature of the spine; as writing, drawing, playing the harp, or other exercises in the course of school training. One of the most extreme cases I ever met with had occurred in a lad, from carrying a medicine-basket on one arm, eight or nine hours daily, for a period of five years. From increasing weight of the trunk, weakness of the supporting muscles, or from both causes, favoured by any occupation conducive to the operation of either cause, lateral curvature is liable to result. *Inequality in the length of the legs*, from any cause, has some influence in producing lateral curvature; but which, according to Mr. W. Adams's observations, has been greatly exaggerated by most writers. Thus, a limited importance may be attached to shortening of one leg; whether as a congenital defect, by dislocation, or from imperfect development; or as resulting from disease of the hip-joint, or paralysis, or from the use of a wooden-leg. *Diseases of the chest*, followed by contraction of the thoracic parietes, often give rise to lateral curvature, as after tapping for empyema; and the same effect may be produced by thoracic and abdominal tumours.

But these accredited causes do not explain certain essential characters of this deformity; to wit, the great frequency of dorsal curvature to the *right*, and the production of *rotation*. Assuming that the right arm is heavier than the left, and the right lung more capacious than the left, Mr. Barwell attributes rotation to the action of the *serratus muscle* of this side; which muscle being more weighted and in stronger respiratory action than its opponent, acts upon the ribs as powerful levers, and thus rotates the vertebræ to the left side. In this etiology, the sequence of events, as usually described by authorities on lateral curvature, is reversed. It is generally stated that the spine first curves laterally, then rotates, and in this latter movement, by dragging with it the ribs, deforms the chest. The rotation-theory affirms that the ribs are primarily drawn backwards, and acting as levers, twist the vertebræ to the left, curving the dorsal spine to the right. Both these views cannot be true, but both are entitled to consideration.

Consequences.—For some time, the spine retains its flexibility; so that when the cause of curvature is removed, the column regains its natural direction. Consequently, in the recumbent position, recovery temporarily takes place. At a more advanced period of the disease,—after the lapse of some years,—the vertebræ become fixed; and then the deformity is persistent in whatever position the patient be placed. Yet recovery can be slowly effected by proper treatment. The general health also is now more visibly impaired; emaciation and pallidity having increased with continued declining nutrition, and there being some symptoms resulting from compression of the thoracic and abdominal organs.

FIG. 747.



Treatment.—Any cause in operation must be removed. Thus, any one-sided posture, connected with occupation or habit, must be corrected; and the patient allowed free motion of the body, alternated with rest in the recumbent position. The correction of posture, in the production of lateral spinal curvature, can be brought about by an antagonistic position. This may be accomplished by using the *sloping seat.* (Fig. 747.) By uplifting the left side of the pelvis, when depressed by lateral curvature and a lumbar arc formed on the left side, the spine is compelled, by the law of equilibrium, to curve in the opposite direction,—to the right, for maintaining balance; and thus a corrective action is established. The results of this mode of treatment are said to have been "perfectly marvellous." Various *gymnastic* exercises have been recommended, and may be of some use; but the ordinary exercise of walking and running will probably bring both sides of the body into equal action, and the spine naturally regain a straight direction. This result will be promoted by due attention to the improvement of the general health, on ordinary principles of treatment.

In *single* lateral dorsal curvature, unaccompanied by any compensatory curve in the lumbar region, either of the annexed forms of *spinal support* may be worn, with much benefit. (Figs. 748, 749.)

FIG. 748.

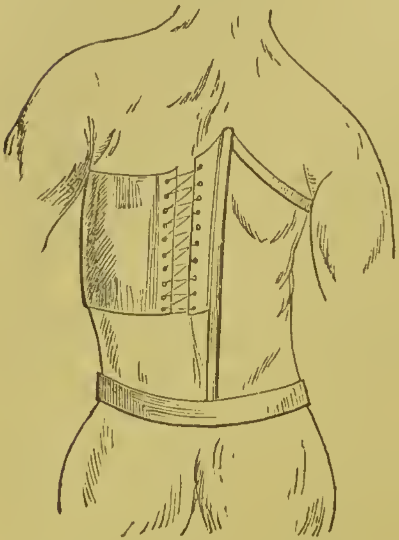


FIG. 749.

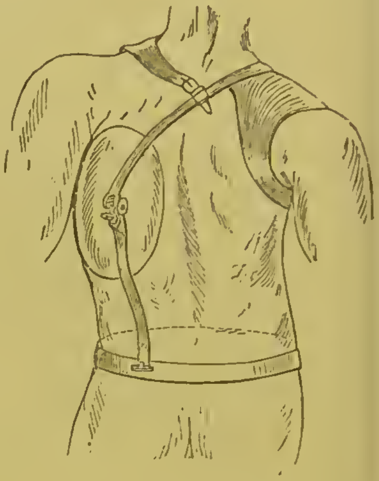
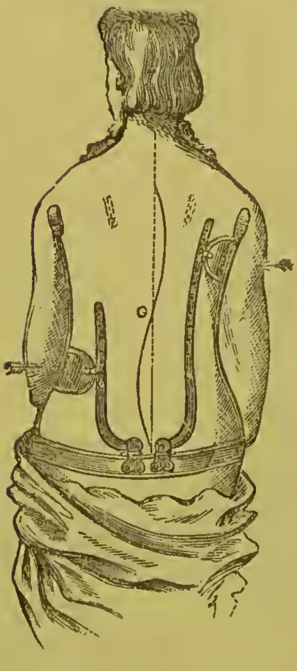


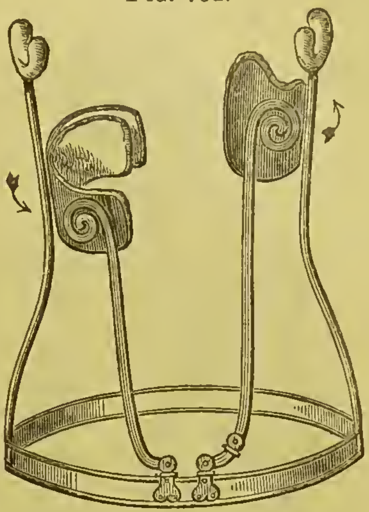
FIG. 750.



In a more *advanced stage*, and as *double* lateral curvature, some other mechanical means must be had recourse to for the gradual correction of this deformity. Various contrivances are used, and still more have been constructed; some specialists in this branch of surgery seeming to vie with each other in designing the most complicated apparatus. The thorax, bulging backwards and outwards at the angle of the scapula; and the hip or haunch, projecting backwards and outwards; both require support, equal and opposite in these directions.

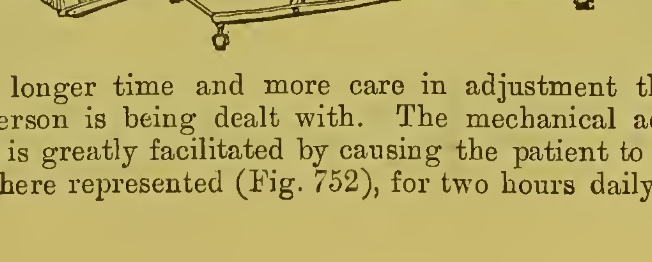
The simple "oblique bandage" answers this purpose very well, so far as regards the bearings of the support. Or, a contrivance, similar in character to that used for angular curvature, may be worn, to relieve the weight of the trunk by crutch-supports; whereby also the varying degrees of lateral pressure requisite, can be better *regulated* by a rack and pinion worked by a key. The primary dorsal curve may, it would seem, be "unfolded," by extending its extremities (Fig. 750); in this way restoring the line of the vertebral column. Unfolding is accomplished, most effectually, by raising the upper extremity of the curve, and supporting its convexity at the same time, as shown in the figure. Replacement of the ribs and scapula, or of the projecting shoulder, consequent on spinal rotation, must also be accomplished; and this requirement is specially provided for, in conjunction with rectification of the double curvature, by Bigg's spinal instrument. (Fig. 751.)

FIG. 751.



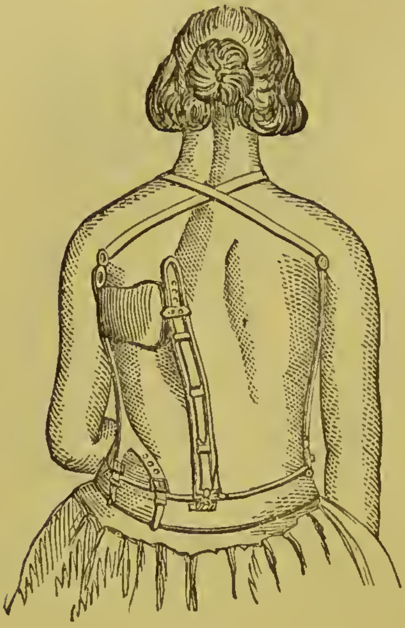
Application of the Instrument is thus described by Mr. Bigg, in his "Manual of Orthopraxy:" "Stand behind the patient, and, opening the pelvic band, place it firmly around the hips, in such a manner that the arms rest upon the crutches. See that the two plates press gently against the arc of each curvature, the vertebral levers having been expanded previous to placing the instrument on the patient's body. Fasten the lacing bands in front, and then gradually tighten, by means of the key which belongs to the instrument, the vertebral levers. Lastly, see that the arm-slides are at such a height as to maintain the shoulders parallel with the pelvis, and fasten the shoulder-straps. As a certain amount of irksomeness is sure to be felt on first adopting any kind of mechanical appliance, the instrument should be so worn as to gradually accustom the patient to its restraint. This is easily done by wearing it for four hours the first day, six the next, eight on the third, and for the whole day afterwards, after which time the patient readily submits to it, and always feels greatly disinclined to part with the apparatus. Where the patient is young, restoration of the spine to its straight position becomes a perfect certainty, provided that great care is bestowed upon the adaptation of the mechanism. The pressure requires to be slightly increased at intervals; and many Surgeons deem it desirable to keep the instrument applied by night as well as day, thus taking advantage of the short time left for rapid improvement. In adults, great and beneficial change can be wrought in the position of even the worst form of lateral curvature, but it requires a longer time and more care in adjustment than when a younger person is being dealt with. The mechanical action of the instrument is greatly facilitated by causing the patient to recline on a chair as is here represented (Fig. 752), for two hours daily; as by this

FIG. 752.



means additional rest is given, and also the mechanical powers of the instrument are left to exercise a freer influence than when opposed by the constant reaction of the patient's weight and muscular resistance. In cases where I have tried an instrument only, and in others where recumbency has also been added, a great difference of progress in favour of the latter course has been observed." By an instrument similar in principle to this, I have succeeded in arresting the increase of one of the worst cases of double lateral curvature.

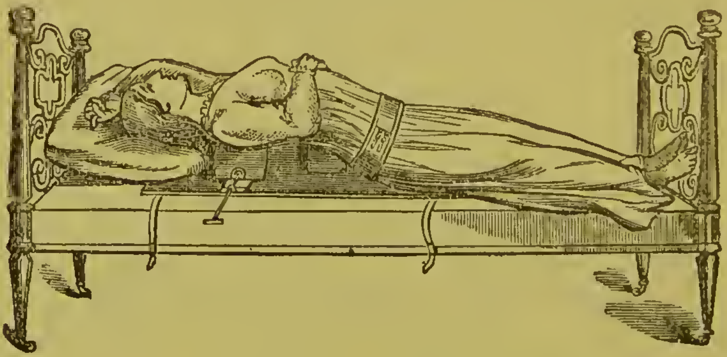
Fig. 753.



Pressure on the dorsal arc, *without* vertical elongation, as the principle of treatment, is represented by the accompanying form of spinal instrument,—which is much advocated and in constant use. (Fig. 753.)

The reduction-couch of Buhring is a means of applying the *unfolding* principle of treatment to double lateral curvature, by *recumbency*. And Dr. Bauer, of Philadelphia, who highly praises this contrivance, observes that it differs from all other spinal couches, and appliances, in this special advantage: that the pads which act on the vertebral curves rest against the transverse and spinous processes, instead of upon the lateral surface of the ribs. Compression of the thorax is thus avoided; whilst, from the thickened shape of the pads, rotation of the vertebræ is induced. The apparatus, as described by Mr. Bigg, consists of a padded metal plate, sufficiently large to admit of the body reclining upon it. Corresponding with the position of the pelvis, a steel band is fixed which surrounds and firmly retains the hips in contact with the couch. Under the left arm an axillary pad, governed by a long screw, is placed, and it raises the concavity of the upper and dorsal curve, whilst, on the convexity of this curve and the right side of the couch, a pad softly covered and shaped like a thick wedge presses upon the transverse and spinous processes of the dorsal vertebræ. On the left side, another pad of a similar wedge-shaped form, but less in breadth and thickness, rests against the spinous and

Fig. 754.



transverse lumbar processes. Both of these pads are moved by horizontal screws, so placed as to admit of the spine being pressed in an antero-lateral direction. The effect of this mechanism is shown in the adjoining sketch, which represents a patient undergoing treatment upon a Buhring couch. (Fig. 754.) It will be seen that the pads not only act upon the body laterally, but also raise the thorax upwards,—thus overcoming rotation of the spine. As the weight of the body rests almost entirely upon the pads, an antero-lateral movement of the vertebræ takes place,—the spinal curves becoming reduced by a kind of unfolding process, peculiar to this contrivance. A loop of leather fastened to the pillow enables the patient to assist the expansion of the dorsal curve, by holding the left arm across and above the head.

Much care should be observed in the construction of this couch, so that the pads may bear strict relation in their form and thickness to the condition of rotatory-lateral curvature presented by the patient's spine; but as the pads can be easily removed by a simple arrangement in the plate attached to the screw, a very little practice soon determines with accuracy the exact size and thickness of padding required in the individual case. Dr. Bauer says that patients rapidly become accustomed to the frequent use of this couch, and derive the greatest comfort from its use, readily sleeping all night upon it.

Treatment by Suspension and Plaster of Paris Bandage.—Dr. Sayre,* of New York, in the year 1876, applied to the treatment of lateral curvature of the spine the same method of suspension, and the application of a plaster of Paris jacket, which he had previously used in the treatment of angular curvature, and has been already described when speaking of Pott's disease (see pp. 409, 410). It was found by Dr. Sayre that in cases of lateral curvature the spine straightened considerably during the process of suspension, and he therefore proposed to maintain the improvement thus gained by the application of the plaster of Paris jacket whilst the patient is suspended. Sufficient time has not yet elapsed to afford a test of the value of this method of treatment, but there can be no doubt of the efficiency of the plaster of Paris bandage as a retentive support. In all probability, it will be found useful in preventing the increase in cases of severe curvature, and in some cases improvement may be effected by the repeated application of the plaster of Paris jacket, and the continued use of suspension. In cases of slight lateral curvature, however, it would interfere with the employment of gymnastics, which together with partial recumbency, and in some cases the addition of a steel spinal support, is found to be amply sufficient for curative purposes. (Note by W. Adams.)

POSTERIOR CURVATURES OF THE SPINE.—*Cyphosis* is a term intended to signify an *excurvation* of the spine in the dorsal region, exhibiting a remarkably *round*-backed appearance. (Fig. 755.) The left figure shows this deformity, and an apparatus which, from the direction of pressure on the spine—*above* the curvature—would increase it; while the adjoining figure indicates the proper situation for spinal support,—about two vertebræ *below* the *axis* of distortion. The most notable instance I have ever seen was in the person of a Surgeon, about fifty years of age, and whose general health remained unaffected.

Lordosis denotes *incurvation* in the lumbar region, and is of more rare occurrence. (Fig. 756.) Both these spinal curvatures appear to be simply an enlargement of the natural curvatures existing in their respective regions; they thus differ from angular curvature, and also in being unconnected with caries or other disease of the spine. Lordosis, to a limited degree, may also occur in the *dorsal* region, as a compensatory incurvation to angular curvature in the cervical or lower dorsal region, resulting from caries; or dorsal lordosis is sometimes associated with double lateral curvature, the vertebral column arching forwards as well as sideways. In the *cervical* region, lordosis to some extent accompanies caries of the first two vertebræ, a compensatory incurvation taking place in the neck below.

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* *Op. cit.*

Fig. 755.

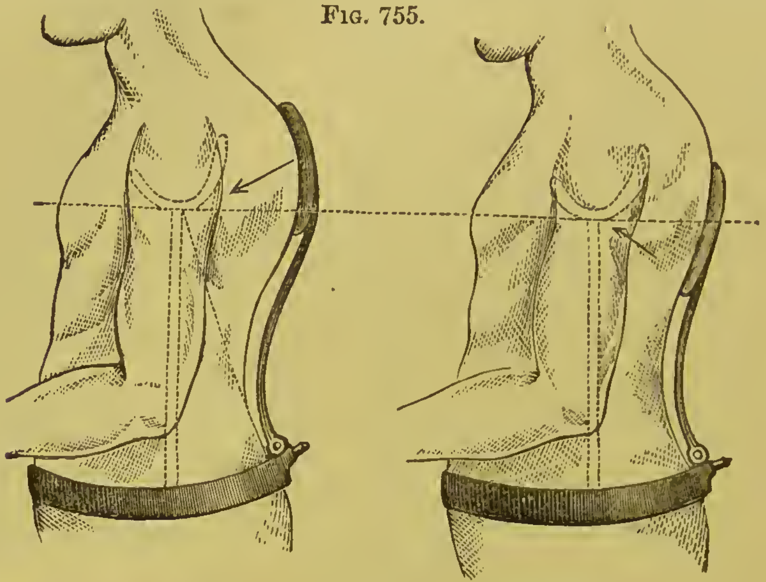
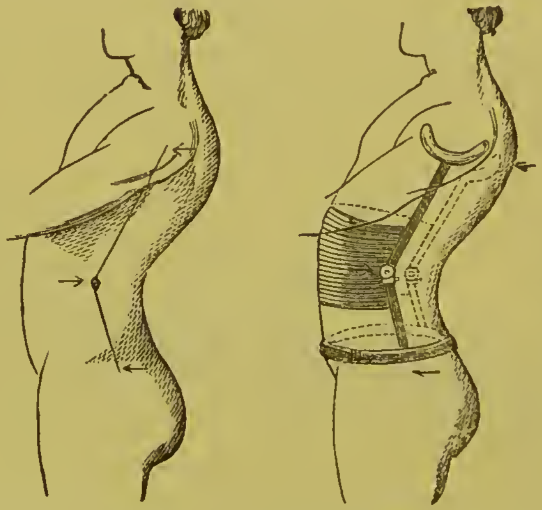


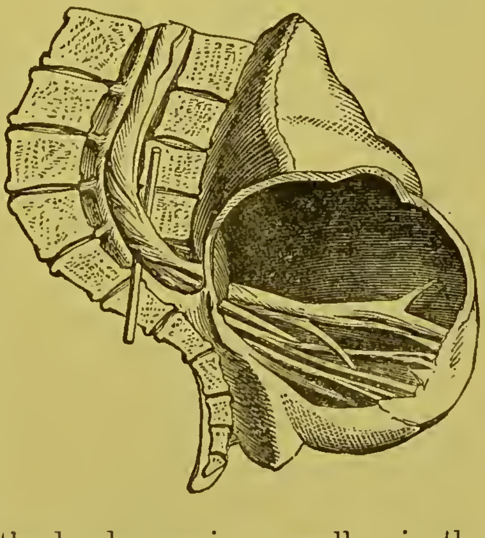
Fig. 756.



Causes.—Cyphosis results from weakness of the dorsal muscles, whereby posterior curvature takes place in the dorsal region. Hence the influence of occupations in the stooping position, as gardening, or driving on the box of a carriage or coach; and the predisposition which arises from age—an early or advanced period of life. Infants are subject to this form of spinal curvature, from being nursed too soon in a sitting posture. *Lordosis* occurs as a natural tendency in rickets; the pelvic bones yielding under the weight of the trunk, the sacrum inclines forwards, carrying with it the lumbar portion of the vertebral column. The influence of occupation is witnessed in the lumbar lordosis of tumbling boys and acrobats. Caries of the lumbar vertebræ is attended with an arching forwards in this region; or a secondary and compensatory curve forms in this direction, with excurvation from disease in the dorsal region. Disease of the hip-joint, and especially after anchylosis with flexion of the femur, is perhaps always accompanied with lumbar lordosis, as well as some lateral curvature. I had a marked example of this in a little boy, whose knee I excised; the patient having also anchylosis of the hip, with flexion of the thigh to such a degree that any attempt to depress the limb caused a semicircular arching of the spine over the bed, in the lumbar region. Unreduced dislocation of the femur backwards, or similar congenital dislocation of one or both hip-joints, results in lumbar incurvation.

The *Treatment* should be conducted on the same mechanical principles of counter-support or pressure, gradually applied, as in the management of lateral curvature. The apparatus for *Cyphosis* has already been noticed. (See Fig. 755.) For *Lordosis*, a stay-apparatus should be worn, having upright crutch-supports to relieve the weight of the trunk, but provided with a padded back-plate, or an abdominal band (see Fig. 756); the former appliance resembling the apparatus used for anchylosing angular curvature. In the two figures —that to the left shows where the axis of the curve is to be found, as indicated by the *arrow;* that to the right depicts the abdominal support, and joint of the upright, so placed as to correspond exactly with the centre of curvature. As associated with caries, or with lateral curvature, the treatment of dorsal lordosis forms part of the management of these conditions; and so also in regard to cervical lordosis with caries.

Fig. 757.*



Spina Bifida.—*Structural Conditions.*—A congenital malformation, signifying the absence or deficiency of the laminæ and spinous processes of some of the vertebræ, with protrusion of the membranes of the cord through the opening thus left in these bones. (Fig. 757.) The sac formed contains a thin, clear, colourless fluid,—cerebro-spinal, which accumulates as the protrusion increases. This structural defect, resulting from an arrest of development, may be found in any part of the spinal column; in the lumbar region, usually; in the dorsal or cervical region, rarely. The spinal cord and nerves are not generally involved; but above the lumbar region, they are liable to be adherent to the interior of the sac; or lower down, in the sacral region.

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* St. Thomas's Hosp Mus., LL. 5.

The *symptoms* of spina bifida are obvious. A round or oval tumour, varying in size from a walnut to a child's head; lobulated occasionally. Of hard, but elastic consistence, fluctuation is obscure. These characters are most marked when the infant is placed upright, softness and fluctuation becoming perceptible in the horizontal position of the trunk. The tumour subsides also somewhat on pressure, but its tension is alternately increased and diminished by expiration and inspiration. Paralysis and wasting of the lower limbs I have also seen well marked in one case, and involuntary defecation.

The *course* of this malformation is uncertain, varying principally according to the size of the tumour. If the sac be small and remain stationary, it may not shorten life. A large sac generally has a fatal termination; death occurs from convulsions, or, inflammation and ulceration of the integuments taking place, spinal meningitis supervenes.

Treatment.—This also, guided by the probable course of the tumour, will depend on its size. A small sac, with healthy integuments, is best left alone; the patient wearing a soft pad over the tumour, simply as a further protective covering. A larger-sized sac, and with the integuments in the same healthy state, may be restrained by a compress and bandage; an india-rubber air-pad affords the most uniform and elastic support. Increasing tension can be relieved by puncture as occasion requires, and pressure should then be reapplied. Extirpation has been resorted to successfully; but this procedure, or indeed any operative interference for removal of the sac, is always more perilous than the tumour itself.

THE THORAX.

CHAPTER LIII.

INJURIES OF THE THORACIC PARIETES, AND ORGANS.

INJURIES of the chest are common accidents in Civil Practice, while they form a very important section of Military Surgery. The chief practical distinctions of these injuries are as follow.

WOUNDS OF THE PARIETES OF THE CHEST.—These lesions, not penetrating the thoracic cavity, present nothing peculiar in their pathology and treatment. Rest of the injured part will be best secured by means of a broad rib-bandage, thus restricting the breathing to abdominal respiration, as in the treatment of fractured ribs or sternum. This appliance must be removed if the restraint prove distressing to the patient.

INJURIES INVOLVING THE THORACIC ORGANS.—Whatever part of the thoracic parietes be injured—the ribs or sternum; and whatever internal organ be implicated—the lung, heart, or great vessels; certain symptoms are common to these injuries, coupled with special symptoms according to the situation of the injury as implicating a corresponding internal organ.

Causes.—*Fracture* is the most frequent form of thoracic injury in connection with wound of the lung, the pericardium, or heart; the ribs or the sternum, respectively, being the seat of fracture, and the broken ends of bone, thence driven inwards, being the immediate cause of the injury to either thoracic organ. *Contusion* or *compression* of the chest, without fracture, as by a violent blow or squeeze, may directly rupture the lung, pericardium, or heart. A musket-ball, apparently bruising the skin only, has been known to cause hæmoptysis, evidently by rupture of the superficial pulmonary vessels; or such cutaneous injury, as it were, may be followed by pleurisy or pneumonia. The heart has been ruptured by indirect violence; as by a fall on the head, shoulder, or lower extremities. Spasmodic contraction of the heart, under the influence of great mental emotion, is also said to have caused rupture; the unhappy sufferer dying literally of a broken heart. Lastly, a *penetrating wound* of the chest, as by a stab with a knife, a bullet, or other gunshot injury, may also directly implicate either organ; but this occasion of internal injury is comparatively rare in civil life. In warfare there are fewer cases of bayonet-wounds of the chest than might be imagined.

Symptoms.—The shock of injury is always well marked, with perhaps faintness from loss of blood, amounting sometimes to extreme collapse; although this state may be partly due to terror or depression.

If the *Lung* be wounded or ruptured, there is also sudden dyspnœa, with a tickling spasmodic cough and bloody-frothed expectoration, or considerable hæmoptysis of pure blood. As arising from gunshot wound of the chest, involving the lung, hæmoptysis may not occur until after the lapse of several hours, or even days. But spitting of blood is no certain indication of the lung being wounded; for this symptom may arise from concussion or compression of the chest. Bloody expectoration, or even hæmoptysis, is therefore not to be regarded as a pathognomonic sign that the lung is wounded, in connection with a penetrating wound of the thorax. The air inspired escapes at the seat of pulmonary lesion, into the cavity of the pleura; constituting *pneumothorax*, with proportionate *collapse* of the lung. If the costal pleura also be wounded, the imprisoned air, passing during expiration from the pleural cavity externally, infiltrates and distends the cellular texture, perhaps to a great extent; constituting *emphysema.* But this symptom also may be absent; as when a penetrating thoracic wound is of large size, so that no air collecting in the pleural cavity, there is none expelled. And the escape of air affords no sure evidence of lung-lesion; for air passes in and out of the pleural cavity during respiration, when the wound is of small size. Hæmorrhage taking place into the pleural cavity is known as *hæmothorax.* The lung may protrude to some extent through a penetrating wound of the thorax, forming *hernia* of the lung.

The consequences of injury to the lung may be; inflammation of that organ—*pneumonia;* and with regard to the pleura—*pleurisy;* terminating perhaps in pus-formation and its accumulation within the pleural cavity—*empyema.*

If the *Pericardium* or the *Heart* also be injured, then, in addition to the extreme collapse, the only peculiar symptoms will be as connected with the pericardium; hæmorrhage taking place into its cavity, or inflammation of that membrane—pericarditis—ensuing, when life is sufficiently prolonged for this event.

Different parts of the heart are liable to be wounded, and, according to Ollivier's inquiries, in the following order of frequency:—right ventricle, left ventricle, the apex or base, right auricle, left auricle.

Rupture of the heart occurs also in different parts of the organ, with some relative order of frequency—as shown by Gamgee's collected cases. Of 27 instances, in at least one-half, the pericardium was entire; in 12 the rupture was on the right side, in 10 on the left. The right ventricle was ruptured in 8, the left in only 3 cases; the left auricle was torn in 7, the right in only 4 cases.

Prognosis.—Wounds of the *Lung* are always perilous, but less so than similar injury of most other viscera. The cause and depth of the wound will mainly determine the prognosis. Thus, a wound produced by a fractured rib is rarely fatal, either in itself or its consequences; whereas contusion, causing rupture of the lung, is frequently more serious; and a penetrating wound is always dangerous, proportionately to its depth. Hence, a stab may soon prove fatal, although I have seen a case where the lung was penetrated by a fork, as shown by the bloody expectoration, and yet the patient soon recovered. A bullet-wound is most perilous, owing to its depth and the uncertain extent of the injury; perhaps implicating the root of the lung. The presence of a ball, as a foreign body, within the thorax is always a sure ground for very grave prognosis. Thus, Dr. McLeod states that, of thirty-three such cases, only two survived. Rare instances of recovery are not unknown; in one case, the ball became encysted in the lower lobe of the lung, life was prolonged for six months, and then death resulted from disease unconnected with the injury; in another case, Mr. Arnott found the fragment of an iron hoop in the lung, which had been lodged therein for a period of fourteen years; and Boyer discovered a ball, the patient having lived for no less than twenty years. But more than half the cases of gunshot wounds of the chest die. After the battle of Toulouse, of 106 cases, it would appear that nearly half died; and of 40 cases at the Hôtel Dieu, 20 died. Of *penetrating* chest wounds only, out of 164 such cases in the British Army during the Crimean War, 130 died,—a mortality of 79·2; while, in the French Army, the death-rate from these wounds rose to 91·6; and of 200 cases in the Russian Army at the siege of Sebastopol, only 3 recovered; whereas, in the Franco-Prussian War, of 30 patients, Billroth lost only 9, or at the rate of 30 per cent.; but in about the same number of cases among the French at Sedan, and the Germans at Metz, the mortality rose to 54·8 and 55·8 respectively. On looking at the far larger returns of the American War (1861–65), we find that, in 8404 cases, the death-rate was 62·5,—when the chest had been penetrated, and probably the lung wounded. This may be taken as the average mortality. The usual cause of death is hæmorrhage, primary or secondary. And, according to Hennen, death generally occurs before the third day; after which, if the patient survive, the prognosis will be favourable for recovery, subject to the contingencies of inflammation and its consequences as affecting the lung and pleura. Wound of *both* lungs is always more dangerous; and principally owing to double pneumothorax, with collapse of the lungs, inducing more complete asphyxia. Recovery is, however, an occasional termination, even in such cases.

Wounds of the *Heart* are generally fatal, and almost immediately, from internal hæmorrhage and collapse. Sometimes life continues for a period of some duration; the patient may have walked or run a considerable distance before falling down dead. In twenty-nine cases, collected by Ollivier and Sanson, of penetrating wounds of the heart, forty-eight hours elapsed before death ensued. But here the direction of the wound, and the cavity of the organ injured, are very important prognostic considerations, when any such particulars can be ascertained during life from the mode in which the injury was inflicted. Thus, a wound in the direction of the axis of the heart is not so speedily fatal as a transverse wound; and a wound of the auricle is more immediately fatal than that of the ventricle, this difference depending probably on some obstruction to the free escape of blood by an irregular contraction of the muscular fibres, owing to their structural arrangement, in the wall of the ventricle. In exceptional cases, life may be prolonged for some days, or recovery has been known to occur, and even although a foreign body remain lodged in the heart. In one instance, Ferrus relates that a man lived twenty days with a skewer transfixing the heart from side to side. In another case, a boy lived five weeks with a piece of wood, three inches long, sticking into the right ventricle; as discovered after death by Messrs. Davis and Steward. A soldier, whose case Latour records, lived for six years after a wound in the right ventricle, from a musket-ball which remained lodged against the septum; and Carnochan relates that a man lived eleven days with a bullet deeply buried in the apex of the heart.

Rupture of the heart, without penetrating wound of the chest, is generally fatal almost instantly; but life may be prolonged for some hours, fourteen hours having elapsed after rupture of the right auricle, as recorded by Rust.

In two instances perhaps, and in one certainly, the chest has been completely transfixed, and yet the individuals recovered and lived for years afterwards. One such case happened in the person of a sailor, whose thorax, through the cardiac region to the back, was transfixed by a trysail mast, an iron-pointed shaft, which fell on him from a height on board ship, pinning him to the deck (1831). The shaft was with some difficulty extracted from the chest. I had an opportunity of examining this man many years afterwards, and he was then in good health and without any thoracic inconvenience. I communicated a report of the examination I made to the *Lancet*, about 1859. In another and previous instance, transfixion of the chest (?) by the shaft of a chaise was followed by a recovery of eleven years' duration. The original history of both these remarkable cases, with the instruments of penetration, is preserved in the Museum of the Royal College of Surgeons.

Treatment.—A penetrating wound of the chest presents certain general indications of treatment. (1.) Hæmorrhage must be arrested. The wound may be accompanied with hæmorrhage from two sources: the arteries of the parietes, or the vessels of the lungs. The former are less frequently the source of hæmorrhage. An *intercostal artery* is seldom wounded, the vessel lying under cover apparently of the groove in the lower border of the upper rib of the two. Yet occasionally the artery bleeds freely, even to the amount of four pounds of blood, into the pleural cavity. The integumental wound must then be enlarged, if necessary, to reach the bleeding vessel, which may be secured by ligature or torsion. Compression may sometimes be more practicable;

and this is best accomplished, as Desault recommends, by introducing a piece of rag in the form of a bag, and stuffing it with small pieces of lint, so as to compress the vessel effectually on drawing the stuffed bag outwards. According to the experience of Bégin, Velpeau, and other Surgeons, there is no risk of thus inducing inflammation of the pleura or lung; and certainly, in any case, this danger should be encountered in order to arrest otherwise uncontrollable hæmorrhage. For the mortality consequent on wound of the intercostal arteries is very high; in the American War, eleven out of fifteen cases had a fatal result, or 73·4 per cent. The *internal mammary* artery, which is rarely wounded, must be ligatured or twisted, the external wound being enlarged when necessary for this purpose. The costal cartilage overlaying the artery may be divided in order to reach the vessel. Blood extravasated into the anterior mediastinum or the pleura, can be partly withdrawn through a female catheter or by the application of a cupping-glass. *Pulmonary* hæmorrhage is the chief source of danger; but the treatment is constitutional, and will be specially noticed after completing the local management of the wound. (2.) Foreign bodies are sometimes discovered, on carefully examining the wound by gently introducing the finger. But the Surgeon must not forget that although, when the chest is perforated, one of two balls, or a portion of a split ball, may have lodged; yet, with only one opening in the chest, the ball may have fallen out, or have been withdrawn in a pouch of clothing. According to a well-known story, an officer whose chest was being examined at length exclaimed, "What are you doing?" "Searching for the ball," was the answer. "I wish," said he, "you had told me sooner, for you will find it in my waistcoat-pocket." A probe should never be used, lest a simple integumental wound be thus accidentally converted into a penetrating wound of the chest. Any foreign body within reach that can be fairly extracted, or by enlarging the wound, must be removed; such as clots of blood, a splintered bit of rib, or a bullet. If not accessible, the substance had better be left to find its way out; or, remaining within the chest, it may lead to the formation of abscess and be coughed up with purulent expectoration, or perchance be expelled through a fistulous channel in the wall of the thorax; or, the body may become encysted in the lung and quiescent, thus lodging in the chest for years. A bullet has been known to continue rolling loosely about in the pleural cavity. (3.) The closure of a penetrating wound of the chest should be determined by two considerations: the probability of a foreign body not remaining in the wound, and by whether the lung be wounded. A *small* puncture, without the escape of air and blood during expiration, and unaccompanied with bloody expectoration, is a condition which permits of the wound being closed. This can be done by means of the ordinary appliances; one or two sutures perhaps, a pad of lint, and strips of plaster. A rib-bandage also may be used to restrict the breathing to abdominal respiration.

A wound of the chest which involves the *lung*, as shown by air and blood escaping through the wound from the injured lung, is a condition wherein the external aperture should not be closed. Water-dressing may be applied, but the patient should be placed on the wounded side, in order that the air and blood may be freely discharged. Pneumothorax and the tendency to emphysema, and perhaps hæmothorax, will probably thus be prevented. This general rule, as to the position of the patient, must not be made absolute. If the position prove intolerable, he may be allowed to lie in whatever position is most comfortable to him; but the almost inevitable consequences of an unsuitable position should not be overlooked. On the other hand, three exceptional conditions are worthy of notice, in either of which the proper practice will be to close the wound, although the lung be involved. With pneumothorax to such an extent as to threaten suffocation, the external wound should be closed, at least so long as the breathing is thus relieved; with pulmonary hæmorrhage, and blood escaping through the external wound to an amount which threatens fatal syncope, the same precaution should be taken, in order that, by allowing the blood to accumulate within the pleural cavity, a clot-compress may form over the pulmonary wound,—but, in the event of the breathing becoming oppressed, the thoracic wound should be at once reopened to discharge the blood; lastly, with perforation of both pleural cavities, the admission of air should be prevented, which would otherwise soon prove fatal. Under these circumstances, it may be advantageous to adopt the method of "hermetically sealing" the wound,—by paring, metallic suture, and wool-compress saturated with collodion, as proposed and practised with more or less success by Dr. Benjamin Howard, of the United States Army.

Constitutional treatment consists in the remedial measures appropriate for arresting pulmonary hæmorrhage. Perfect quietude, so that the breathing shall be as placid as possible, must always be enjoined; for healthy pulmonary texture evinces a strong natural disposition to heal. Astringents may then be administered with advantage, and in particular gallic acid, alum, or acetate of lead and opium in pill. Opiates are also remedial by insuring sleep, and diminishing the respiration. The efficacy of blood-letting in reducing the force of the circulation, as originally inculcated by John Bell, Hennen, and Guthrie, was corroborated by the large experience gained during the Crimean War. Venesection should be had recourse to early and copiously, sixteen or twenty ounces of blood being drawn at once, and repeated to a lesser amount again and again, whenever necessary to suppress hæmoptysis. More recent experience during the American War is adverse to the practice of blood-letting. I am in favour of one decided and, as it may be termed, knock-down abstraction of blood, when the pulmonary lesion will probably undergo repair sufficiently to arrest hæmorrhage before the pulse rises and bleeding can recur.

Inflammation supervening after about the third day, it should be met by the usual antiphlogistic treatment; with this difference, that antimony and mercury are scarcely appropriate, owing, as Mr. Lawson has observed, to their influence in checking the exudation of plastic lymph requisite for the reparation of the wounded lung.

Secondary hæmorrhage may arise from inflammatory excitement of the circulation, or after gunshot wound, by the detachment of sloughs; the blood proceeding either from the lung, or from an injured intercostal artery. Venesection is the remedy in the first case; with ligature or compression in the second; and astringents in either case may prove serviceable. The pleural cavity may have become filled, and the lung compressed by air, extravasated blood, or inflammatory effusion, serous or purulent; the wound should then be opened with a probe-pointed bistoury, and free vent given to any such collection. Or, when the wound has closed, it will be necessary to tap the chest; an operation which, in the American War, gave a death-rate of eighty per cent.; but this mortality is not much higher than that from penetrating gunshot wounds of the chest, without such operation.

In connection with gunshot wounds of the chest, it may be necessary to perform the operation of *excision*, for the removal of portions of bone; either as the fragments in compound and comminuted fracture, or consequent on caries or necrosis. Such operative procedures must be governed by general principles, and admit of no special description. Thus, portions of the ribs or the sternum, of the clavicle or the scapula, have been removed with more or less success.

HERNIA OF THE LUNG, or PNEUMATOCELE.—Protrusion of the lung may follow a penetrating wound of the chest, as a stab, or gunshot wound; or, arising after the external wound has healed, it appears under the cicatrix; and it has been produced by fractured rib without wound, or by any violent straining effort, as during labour. Always a rare accident, the protrusion is only, properly speaking, hernial when covered with integument,—a very rare occurrence. The lung itself is seldom wounded, in connection with its protrusion. If the pleura be adherent close to the thoracic wound, or seat of rupture, protrusion will be more likely to occur; whereas, if the lung be in a collapsed state, as with a large thoracic wound, the liability will be less. Any part of the thoracic parietes is liable to hernia of the lung; but more especially one or other side of the chest. The tumour may attain a large size. Owing to the vascularity of the pulmonary texture, and the existence perhaps of a small aperture, a protruded portion soon becomes strangulated; it acquires a deep purple or black colour, and being almost insensible to the touch, it appears as if in a state of gangrene. But the Surgeon may well doubt this event, until the colour has changed into black or grey, and the texture has become softened by disintegration. Inflammation is liable to extend along the pleura, leading to adhesion or effusion.

When covered with integument, hernia of the lung might be mistaken for the bulging of a purulent collection in the pleura,—empyema. But the distinction may be perceived by percussion and auscultation. Strangulation seldom supervenes, as after protrusion from wound.

Treatment.—With an external wound, and the protruding lung in a healthy state, it may be returned into the thorax, while the patient draws a deep breath; or it may be found necessary to slightly enlarge the opening with a probe-pointed bistoury and director, observing to cut across the course of the intercostal muscular fibres. But no enlargement of the wound was required in any of the seven cases which occurred during the American War. The treatment otherwise is that of a penetrating chest wound. Or, the protruding portion of lung may be allowed to remain as a plug to the pleura, according to Mr. Guthrie's recommendation, when it soon granulates and heals over. This should certainly be the rule if the pulmonary texture be bruised and lacerated, or in a sloughy state. Such an exposed portion has been known to slough away. It has also been removed surgically and successfully, even although of considerable size. Tulpius ligatured a gangrenous protrusion of the lung, and cut it off with scissors. The piece removed weighed three ounces, yet the patient entirely recovered. *Hernial* protrusion must be supported by a truss.

PNEUMOTHORAX.—Distension of the pleural cavity with *air*, and an accompanying collapse of the lung, is denoted by certain marked signs; tympanitic resonance on percussion, with an absence of the respiratory murmur and an increased or puerile respiration on the opposite side of the chest, as discovered by auscultation. The affected half of the thorax is enlarged, and the ribs are raised; there is also some bulging of the intercostal spaces. But the movements of respiration are diminished on this side, and the breathing is of course embarrassed in proportion to the pleural distension and pulmonary collapse.

The *causes* of this condition are, surgically, any occasion of wound of the lung; whether by a fractured rib, rupture from thoracic compression, or a penetrating wound of the chest, as by a stab or bullet. But pneumothorax may also arise from a diseased state of the lung, as the bursting of a pulmonary abscess into the cavity of the pleura; air and fluid thus coexisting in this cavity, the fluid below and the air above. Two distinctive signs are then presented: a splashing sound elicited by succussion or shaking of the chest; and metallic tinkling, a clear, silvery, bell-like sound, resulting perhaps from the dropping of fluid occasionally from the pulmonary orifice into the fluid collected at the bottom of the pleural cavity. Coughing will frequently elicit this sound.

Treatment.—The relief of pneumothorax is easily accomplished by tapping or puncturing the chest so that the accumulated air shall escape from the pleura,—the operation of Paracentesis Thoracis. But the causes of which pneumothorax is itself only symptomatic must then be attended to, as in the treatment of a penetrating wound of the chest.

Emphysema.—Distension of the *cellular texture* with air frequently accompanies pneumothorax; although either condition may occur independently. Emphysema almost necessarily depends on a wound of the costal pleura, in conjunction with that of the pulmonary pleura; air escapes into the pleural cavity with each inspiration, and is expelled thence into the cellular texture. If the lung be bound down by adhesion at the seat of both apertures, the air passes directly into the cellular texture; emphysema arises without any previous pneumothorax. An external penetrating wound will also allow air to pass directly into the cellular texture, thus giving rise to emphysema.

A rare mode of production, which Mr. Hilton has described, is by rupture of the pulmonary texture alone; air passing into the posterior mediastinal cellular texture, along the course of the nerves and vessels, thence to the neck, and downwards along the sheaths of the arteries to the limbs.

The *signs* of emphysema are distinctive; a swelling, diffused, somewhat elastic, but plainly crackling under pressure with the fingers, and without any discolouration of the integument. This swelling arising in the neighbourhood of a fractured rib, or around the margin of a penetrating wound, gradually extends through the cellular texture over the thorax. I have seen it thus comparatively limited with fracture of several ribs. Sometimes it passes up into the neck and arms, and downwards to the lower limbs; such general emphysema presents the singular appearance of a stuffed figure scarcely human, and as the internal organs become involved, dangerous symptoms arise, particularly dyspnœa, threatening suffocation.

Treatment specially for this condition may not be requisite. The air infiltrated often becomes absorbed rapidly, and the swelling disappears. Bandaging may have some repressive and absorbent effect. Punctures, well placed, more decidedly control the spread of emphysema; and an external wound, when present, may sometimes be opened with advantage to aid in discharging the imprisoned air. Should respiration become oppressed, venesection, freely employed, will often afford the most marked and instantaneous relief. I cited a case in point from my own observation, when treating of fracture of the ribs.

HÆMOTHORAX.—The presence of *blood* in the pleural cavity gives rise to different signs from those of Pneumothorax. Hæmorrhage may be suspected by dulness on percussion, with absence of the respiratory murmur,—these signs being more marked at first over the most dependent portion of the pleural cavity, where the blood collects; dyspnœa is more or less urgent, and collapse; and all these signs or symptoms are found to have arisen in connection with a fractured rib, or a penetrating wound of the chest. The blood may proceed from the lung or from an intercostal artery. Secondary hæmorrhage, and the circumstances under which it supervenes, may also produce hæmothorax. Blood thus extravasated soon undergoes putrefactive changes, and leads to the formation of pus in the pleural cavity—empyema. Sometimes there is a collection of air above the level of the blood,—a co-existing pneumothorax; and then percussion elicits a tympanitic resonance above the line of dulness. But the respiratory murmur is equally absent all over that side of the chest.

Treatment.—An early opening must be made, both to relieve the breathing and to prevent the risk of empyema. Advantage should be taken of an external wound to make that the vent; a probe-pointed bistoury being carefully used to free the opening. A cupping-glass may be applied to withdraw the blood, if it be not readily discharged. If the hæmorrhage be *persistent* and symptoms of hæmothorax return, the plan recommended by Guthrie may become advisable. The wound is to be closed, so that the blood accumulating in the pleural cavity shall compress the orifice in the lung, and thus arrest any further hæmorrhage; the patient lying on that side as an additional pressure on the wounded and bleeding organ. After the lapse of six or eight days, the wound should be reopened, or tapping may be performed, to evacuate the imprisoned blood; which, if allowed to remain longer, would probably provoke empyema.

HYDROTHORAX.—A collection of *serous fluid*, or water, in the pleural cavity, may be the result of pleurisy; but more commonly this condition arises from disease of the heart or lungs, obstructing the circulation. Both sides of the chest may be affected.

The signs are those of empyema, without the accompanying hectic fever.

Treatment surgically has regard only to the relief of dyspnœa by evacuation of the imprisoned fluid,—the operation of paracentesis thoracis.

EMPYEMA, or PYOTHORAX.—A collection of *pus* in the pleural cavity is usually the consequence of pleuritis; induced by a wound of the pleura from a fractured rib, or a penetrating wound of the chest. The lung may, or may not, be implicated. Occasionally, the irritation of a carious rib, or the bursting of an abscess into the chest, is the cause of empyema.

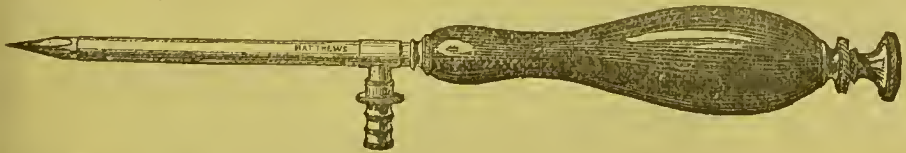
The *signs* are dulness on percussion and absence of the respiratory murmur at the lower part of the chest, up to the level of the fluid; this varying with the upright or recumbent position of the patient. Ægophony—a bleating or reedy voice-sound, something like Punch's voice—is heard at the upper part of the chest; owing probably to a thin layer of fluid rising up between the two layers of pleura, through which the voice is transmitted, as a broken vibratory voice, from the larger bronchial tubes. Pus continuing to collect in the pleura, the line of percussion-dulness gradually rises higher and higher; until the whole side of the chest emits a wooden sound on percussion, and neither breath nor voice sound can be heard. The affected half of the thorax is increased in size, visibly and palpably, and as shown by measurement, compared with the opposite side. The ribs are elevated, and the intercostal spaces are widened and bulge outwards; while the lung is compressed backwards towards the spine, becoming consolidated like unto the consistence of india-rubber, and ultimately perhaps not larger in size than a fist. Empyema of the left pleural cavity displaces also the heart towards the right side; or, if it occur on this side, the liver is depressed by the pleural accumulation. On either side, empyema may displace and compress the opposite lung. The respiratory movements are restricted on the side of empyema, and dyspnœa is more or less urgent as the disease progresses. Hectic fever results from continued suppuration. The abscess usually points and bursts externally, between the ribs; or, having become extra-pleural, the pus diffused in the cellular texture may burrow among the muscles of the back, or find its way into the abdomen, beneath the peritoneum, and even thence down into the pelvis.

Treatment surgically consists in evacuation of the imprisoned fluid.

Paracentesis Thoracis.—Tapping the chest is an operation for the evacuation of any fluid—air, blood, serous fluid, or pus—collected in the pleural cavity; but it is especially and more commonly performed for the relief of the latter accumulation,—empyema.

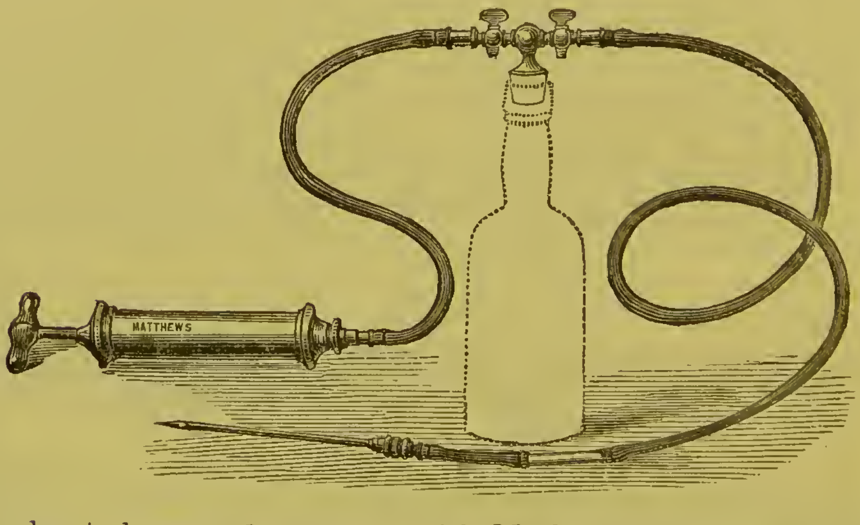
The spot selected for puncture is wherever the abscess may have pointed, or where there is decided dulness,—that the lung shall not be wounded; and the place usually chosen is in the fifth intercostal space, at about its middle on the side of the chest. This about corresponds to the insertion of the serratus magnus. A valvular opening is made in the skin, by drawing it upwards with the finger, from the lower to the upper margin of the sixth rib, a slight incision being made at this spot, with the point of a bistoury; a large-sized, flat-shaped trocar (Fig. 758) is then thrust directly over the *upper* margin of the rib, thus avoiding the intercostal artery, and passed through the pleura. The trocar is withdrawn and the fluid drawn off through the cannula. Air is liable to enter the thorax towards the end of the stream; it having become almost dribbling, air may then be sucked into the pleura during expiration, to fill up the thoracic space unoccupied by

Fig. 758.



the collapsed lung. Decomposition of the purulent fluid would thus be induced, and severe or fatal constitutional disturbance. To obviate any such risk, the cannula should be provided with a stop-cock, which is turned as the trocar is withdrawn; an india-rubber bag is then attached to the projecting end of the cannula, and the fluid safely drawn off; the stop-cock being turned, and the bladder emptied and reapplied, as often as may be necessary to evacuate the purulent collection. A modification of this method is that which I prefer. A long india-rubber tube, instead of the bag, having been fixed to the cannula and its free end placed in a basin of water, the fluid is drawn off as safely under water, and with the advantage to the Surgeon of his being enabled to see when the stream ceases. On withdrawing the cannula, a pad of lint is slid over the puncture-orifice in the integument, and secured by strips of plaster. The admission of air into the pleura would lead to purulent decomposition, and prolonged fetid discharge; and also prevent the re-expansion of the lung. But if there be a foreign body in the thorax, as a bullet, portion of clothing, or a piece of dead bone, the opening should be maintained, or even enlarged, in order to facilitate its escape, or removal by surgical interference. After the operation of paracentesis, a rib-bandage may be used to restrict thoracic respiration. The *drainage-tube* of M. Chassaignac, and adopted by Dr. Goodfellow and Mr. De Morgan, has been employed to prevent any reaccumulation of pus. A long iron probe, slightly bent, is introduced through the trocar-opening, and pressed against an intercostal space posteriorly, as low down as possible. The prominent end having been distinctly felt, it is cut down upon, and pushed out. A silk thread carrying the drainage-tube is attached to the eye of the probe, and on withdrawing the probe at the lower opening, the drainage-tube follows through the pleural cavity; the ends of the tube, projecting from the opposite openings, are tied together, and the purulent fluid drains away, *guttatim*, as it forms. I remember to have read a case in which Mr. Berkeley Hill adopted this resource, in an old-standing empyema, and with most marked benefit to the general health. For the purpose of cleansing the pleural cavity, injections of tepid water, or weak disinfectant solutions of the

FIG. 759.



chloride or bromide of potassium, are very efficacious; but any such fluid should be thrown in with the utmost gentleness, and in moderate quantity, the patient being turned round from one side to the other, so as to rinse out the interior of the cavity. Dr. M. Goldsmith, U.S.V., has employed a solution of bromine and bromide of potassium, with great advantage.

Since Dieulafoy's method of removing fluids by *aspiration* has come into use, this simple and safe procedure has become a substitute for the operation of paracentesis, in cases where the fluid is found to be sufficiently thin to escape through one of the larger-sized aspirator-needles (Fig. 759), or the tube may be screwed on to the cannula of the thoracic trocar. (See Fig. 758.)

Hydrops Pericardii.—A collection of water in the pericardium may result from the same causes obstructing the circulation, as those of hydrothorax; the two conditions not unfrequently coexisting.

The *signs* are—percussion-dulness, extending over the whole pericardiac region, and absence or muffling of the cardiac impulse, with perhaps an obvious fulness to the eye, and to the hand placed over this region. There is constant præcordial oppression and dyspnœa, particularly in the recumbent posture, and faintness on exertion.

Paracentesis Pericardii may be employed as a last resource. A spot of the greatest dulness having been selected, a slight incision is made in the intercostal space, and a small trocar passed obliquely into the pericardium; or the aspirator may be here employed.

Deformity of the Chest and Spine will inevitably result from pleurisy with extensive adhesion, or from tapping the chest, as for empyema, when the lung cannot sufficiently expand. In either case, the side of the chest collapses to meet the inactive lung, and there is more or less flattening deformity.

No mechanical contrivance will be able to control this result. The case is best left to nature, and if the patient be young, he may outgrow the deformity.

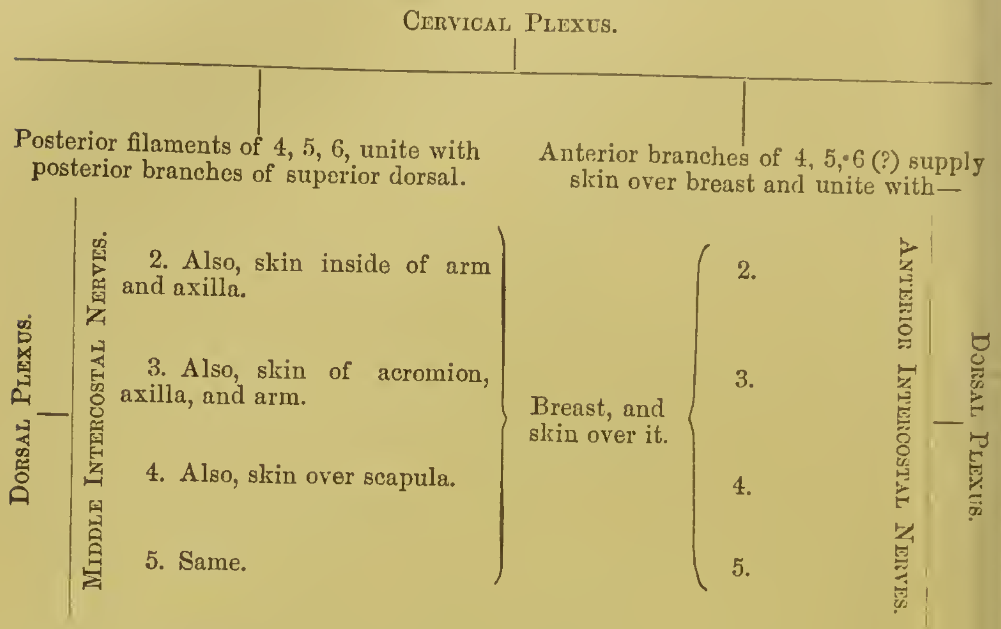
CHAPTER LIV.

DISEASES OF THE BREAST.

In considering Diseases of the Breast, it is absolutely necessary to regard the Mammary Gland in its physiological and anatomical relations; through the nervous, vascular, and lymphatic systems.

The Breasts—meaning thereby the Mammary Glands—are intimately related, physiologically, with the organs of reproduction in the female. A healthy condition of these organs is associated with a healthy state of the breasts, and both undergo differences of functional activity at different periods of life;—before puberty, at puberty, and subsequently, during the menstrual period; and during pregnancy, parturition, and lactation.

The anatomical relations of the breast consist principally in its intimate nervous connections; through the distribution of the spinal nerve-filaments to the skin over the gland, and to the gland itself, and their connections with the cutaneous filaments of the neighbouring regions. This nervous system of the breast, and its source of supply from the general nervous system, is clearly exhibited in the following diagrammatic scheme of *innervation*, by Mr. Birkett:—


Cervical Plexus.
Posterior filaments of 4, 5, 6, unite with posterior branches of superior dorsal.
Anterior branches of 4, 5, 6 (?) supply skin over breast and unite with—
Dorsal Plexus.
Middle Intercostal Nerves.
2. Also, skin inside of arm and axilla.
3. Also, skin of acromion, axilla, and arm.
4. Also, skin over scapula.
5. Same.
Breast, and skin over it.
2.
3.
4.
5.
Anterior Intercostal Nerves.
Dorsal Plexus.

It should be read thus:—The breast and superimposed skin are supplied by filaments from the anterior branches of the 4th and 5th cervical nerves. Filaments from the posterior branches of the same nerves join with others from the superior dorsal nerves. Filaments from the middle and anterior intercostal branches of the anterior division of the 2nd, 3rd, 4th, and 5th nerves of the dorsal plexus, supply the breast and skin over it chiefly. A minute examination demonstrates the association between the 2nd intercostal and filaments supplying the skin of the inside of the arm and axilla; also the same parts, and the skin about the shoulder from the 3rd; and the skin about the scapula from the 4th and 5th. These nervous intercommunications explain the widely extended pain of which patients so grievously complain when affected with mammary hyperæsthesia.

Arteries and Veins.—The 2nd, 3rd, 4th, and 5th intercostal branches of the internal mammary artery usually supply blood to the sternal segment of the breast; within the axillary portion, a large branch from the axillary artery commonly ramifies; and the inferior and lateral regions receive a few branches from the intercostal arteries which accompany the nerves through the middle intercostal foramina. The *veins* accompany the arteries and terminate in the internal mammary and axillary trunks. The subcutaneous veins around the areola are arranged in the form of a circle,—the circulus venosus areolæ of Haller. The superficial veins, ramifying over the breast, are often dilated, and present a blue, open network.

Lymphatic Vessels.—The superficial lymphatics pass through the axillary, the cervical, and anterior mediastinal glands; a deeper series pass over and beneath the pectoralis major muscle to the glands under the clavicle.

GENERAL PATHOLOGY AND DIAGNOSIS OF DISEASES OF THE BREAST.—The mammary gland is subject to the same kind of diseases as other organs; but the physiological relations of this organ give it an almost specially wider range of pathological significance, it being the scene of sympathetic uterine affections, and of inflammation and morbid growths, as perversions of nutrition,—the liability to which varies according to the functional activity or quiescence of the gland. In relation to the influence of external causes, the situation of the breast exposes this organ to cold; or to injury, by the pressure of stays, a blow, or collision.

The general *diagnosis* of diseases of the breast should have reference—observes Mr. Birkett—to certain considerations, which may be expressed as follows:—Has the disease, in question, any manifest connection with the age of the patient; the stage of development of the gland; its functional activity or repose; and the social condition of the patient, as to marriage, etc.? Does it seem to be associated with any disturbance of the functions of the generative organs? Is it merely a local affection, or more intimately connected with general constitutional dyscrasia? Is it of inflammatory origin? Is it traceable to a morbid state of the excretory ducts, or of the secreting structure of the gland? And, lastly, is the swelling, tumour, or tumefaction really produced by something growing in the breast,—a new growth, infiltrating the tissues of the breast, inflammatory or otherwise; or simply a morbid condition of a part or whole of the actual tissue of the organ,—an excited state of the gland-structure; in short, is the disease superadded *to* the gland, or a morbid state *of* the gland-structure?

It will be observed that this order of inquiry is analytical, and that it proceeds by the order of exclusion; both of which methods are most valuable in clinical teaching and investigation. But he who has been thus trained, will come at last to conduct such inquiry unconsciously, or to cut it short, by at once associating the leading characters of the disease, in his recognition or diagnosis of that disease.

Method of Examining the Breast.—The following practical directions—given by the same author—will be found to facilitate the diagnosis of a morbid lobe of gland-tissue from a new growth. Press the indurated part gently between the thumb and fingers, and a tumour is so distinctly felt that the positive existence of something superadded to the breast is affirmed; but now place the fingers lightly and *flatly* upon the part over the site of the supposed new growth, pressing gently against the thorax, and nothing more than the ordinary gland-tissue is perceptible. On the contrary, if there be a genuine new growth, something developed recently within the normal gland, it will be always felt; in whatever manner or in whatever position the patient is examined. For perfect accuracy of diagnosis, the breast should be examined whilst the patient is seated, and also when placed in the recumbent posture.

INFLAMMATION.—MASTITIS.—The earliest change is induration more or less intense, and involving one or more lobes of the gland. Uneasiness, rather than pain, is experienced in moving the arm or in the act of suckling. The lump, knot, or coring of the milk, as it is termed, is due to congestion of the milk in the part affected. This congestion and induration increase with variable rapidity, and the whole gland becomes involved, accompanied with a sense of weight and tension. Integumental swelling and redness supervene with acute pain, and considerable constitutional disturbance or inflammatory fever.

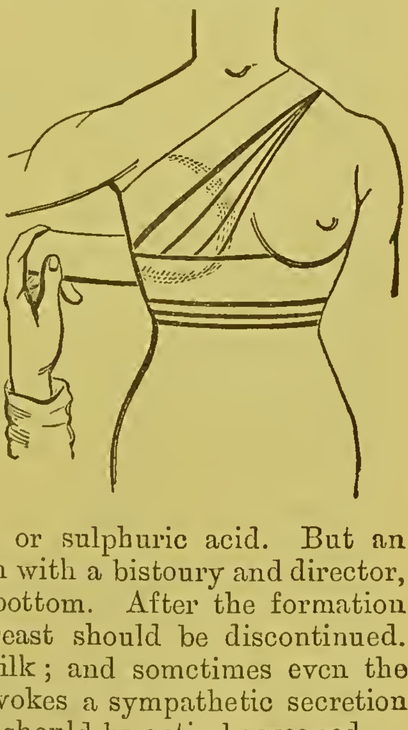
Suppuration usually takes place,—resolution being a rare termination; and pus collects in the breast, on its cutaneous surface, or behind the organ. The formation of mammary abscess may, therefore, be either *super*-mammary, *intra*-glandular, or *sub*-mammary. These different situations of abscess can only be distinguished by careful palpation with the fingers, as to the depth of fluctuation. The first-named abscess is sometimes a primary affection; it enlarges to the size of a walnut or a small egg, and bursts in about a week or fortnight. Intra-mammary abscess may involve the whole gland, in one or more cavities, thus attaining to a much larger size; and it comes to the surface more slowly, bursting usually near the nipple, in perhaps from two to four weeks. The kind of discharge is distinctive of its source; being a mixture of pus and milk, a quantity of thick yellow matter, streaked with white curdy fluid, rolls out of the opening. Sub-mammary abscess is the most characteristic. The breast seems to rest upon and be projected by something behind it, and which yields, on slight pressure, the elastic fluctuation of a water-cushion; with perhaps scarcely any integumental tenderness or redness. Abscess under the breast is not necessarily connected with mastitis; it sometimes appears as a primary affection, and always acquires a considerable size, passing even beyond the boundary of the gland. The matter progresses towards the surface slowly; it points very often, at several spots around the circumference of the gland, or, making its way between the lobular masses of the organ, an opening forms near the areola towards its sterno-clavicular border. Rarely, the abscess points backwards, and opens into the pleura or the anterior mediastinum; and rarely, also, pleurisy is induced by sub-mammary abscess; but in either such case, the peril of this or that complication should make the Surgeon vigilant, and guarded in his prognosis.

Causes.—Inflammation of the breast occurs commonly in the adult female, and during lactation; leading to the formation of *milk abscess.* Both breasts are sometimes affected in succession, an instance of which came under my care. During pregnancy and weaning, the inflammation happens very seldom; more frequently during the former than the latter period, and when at the time of weaning, it is generally excited by an abrupt discontinuance of suckling—owing to the death of the infant or illness of the mother. Some local irritation, not unfrequently, induces it; especially ulceration of the nipple, the irritation of sucking, obstruction of a milk duct, contusion or exposure to cold; and occasionally a diseased state of the axillary glands. On the other hand, the inflammation very rarely arises before puberty, about that period, or during the inactive state of the gland. But I have had one such case, in an Indian girl, only eleven years of age. The abscess projected as if the breast were fully developed; when opened, it discharged freely and healed slowly. In infants, I have known mammary abscess produced by an ignorant practice, common, I believe, in some parts of the country,—that of pulling the nipple "to break the strings of the breast." Sub-mammary abscess, when independent of mastitis, may proceed from caries or necrosis of the ribs, or empyema, by perforation of the thoracic wall.

Treatment.—The usual treatment of inflammation is here applicable, but it should be had recourse to at an early period; in order to anticipate as far as possible the known circumstances under which the disease commonly arises, and prevent its suppurative consequences in the destruction of the breast.

In the first instance, repressive measures should be employed; cold lotions, or the extract of belladonna thickly spread on strips of lint and well applied over the whole breast, a most effectual repressor of incipient inflammation during lactation; occasionally, leeches may be advisable, and derivative aperients when circumstances permit. Additional and special relief is afforded by emptying the gland-tissue of its secretion; removing, in fact, lactic congestion. Suckling need not be abandoned, but it may be necessary to remove the milk mechanically, by means of the breast-pump. The arm of the affected side should be placed at rest, and the weight of the breast supported on the patient's chest; or if she lie sideways, a pillow or loop of broad bandage may be requisite. Established inflammation, with redness of the skin, and almost inevitable abscess, must be met by warmth and moisture; poultices, to limit the inflammation and induce suppuration of a circumscribed character, and facilitate pointing of the abscess. The usual rule of an early, free, and dependent opening is here imperative; although Sir A. Cooper restricted this practice to certain conditions of mammary abscess,—namely, when deeply placed, and of slow progress, attended also with much pain and constitutional disturbance. In any case, a strip of lint should be inserted for two or three days, just to prevent the lips of the wound uniting, and the reaccumulation of matter, and also to induce granulation from the bottom of the cavity. The support of lint-pads, with a bandage (Fig. 760), will be requisite to prevent any tendency to bagging of matter and formation of sinuses, and, subsequently, to promote absorption of the remaining induration, when the pressure of cross-strapping with long strips of adhesive or soap plaster will probably afford a more even and suspensory support to the breast. Stimulant embrocations and ointments may also prove efficacious, such as camphor liniment, with olive oil, or mercurial ointment; but strapping the breast with the emplastrum ammoniaci cum hydrargyro has the advantage of aiding absorption by pressure, as well as by gentle stimulation. Sinuses can generally be closed by pressure, and perhaps occasional syringing with a diluted mineral acid, the nitric, nitro-muriatic, or sulphuric acid. But an intractable sinus may have to be laid open with a bistoury and director, in order to secure granulation from the bottom. After the formation of abscess, suckling with the affected breast should be discontinued. lest the infant draw matter with the milk; and sometimes even the flow of milk from the sound breast provokes a sympathetic secretion in the opposite gland, and then the child should be entirely weaned.

FIG. 760.



Chronic inflammation may be the consequence of acute inflammation, or arise independently as a scrofulous affection. Induration and swelling of the breast, in part or of the entire gland, is usually followed by suppuration, burrowing, and sinuses or fistulæ of an obstinate character.

Chronic abscess must be distinguished from cystic-tumour of the breast. Both having a painless and an indolent character, the history will partly distinguish abscess, and puncture with a grooved needle will always determine the diagnosis.

The *treatment* consists in the evacuation of matter, as occasion requires, and the support of strapping or bandaging; with a tonic and nourishing course of general treatment. Chronic sinuses may be closed by stimulating injections, or by laying them open as a last resource. Milk fistulæ will not usually heal until the secretion of the gland is arrested.

Scrofulous enlargement, or tumour, of the Breast is a result of mammary inflammation in scrofulous subjects. In a marked case under my care, the breast proceeded to abscess, with curdy discharge, followed by obstinate sinuses, and induration, like that of scirrhus, resulting in a hard, puckered cicatrix. But there were also remnant scars of lymphatic glandular abscesses in the neck. Tuberculous deposit also is noticed by Velpeau, and as occurring in two situations: in the gland, or in the skin and subcutaneous cellular textures. The *axillary glands* are sometimes the seat of this deposit. I removed a conglomerate bunch of these glands from the axilla of a middle-aged single woman; the deposit being yellow, opaque tubercle, mixed with cretaceous matter.

Inflammation of the Nipple.—This affection often arises during suckling, and leads to superficial ulceration or excoriation, as *cracks*, *fissures*, or *chaps*. Great pain attends the act of suckling, and inflammation of the breast may be induced.

Treatment.—Frequent ablution with warm water often proves more remedial than lotions, ointments, or other applications. These may be simply protective; as collodion, glycerine, almond oil, or some dry powder, as prepared chalk or flour dusted around the nipple; stimulating applications, as a touch with nitrate of silver; astringents, as tannin or zinc ointment; and narcotics, to relieve pain. The difficulty is to manage the breast in a state of secreting activity, and the suckling of the child, the nipple or perhaps both nipples being sore. Some of the above-mentioned applications would be decidedly poisonous to the infant; narcotics in particular. Various shields have been devised to protect the nipple from the pressure and dragging caused by the act of sucking; and such a contrivance will also shield the infant's mouth from any noxious matter left around the nipple, in the use of these curative applications.

Abscess of the Nipple or of the areola has no special characters or treatment.

Other diseases of this part, as tumours, are not peculiar.

CHRONIC INDURATION of portions, or of the whole, of the mammary gland is another common condition; the induration having a finely *lobular* or *granular* character, owing to the acini or cæcal terminations of the lactiferous ducts being gorged with epithelium. This state of the gland may be found in breasts of all sizes and shapes; in the large, heavy, pendulous breast; and in the small, atrophied, disc-shaped organ. The one feels like a great ball under the integuments; the other, under which the tips of the fingers may be inserted, feels like a quoit covered with skin. Indurated portions simulate tumours formed by a new growth; but, although distinctly felt when pressed between the finger and thumb, under pressure flatly against the chest any such portion will be imperceptible as a hard mass. Great tenderness, and even pain amounting to agony, on the slightest handling, is often experienced; the patient's face becoming suddenly suffused with a bright red blush, or pallid, while a sensation of nausea or faintness oppresses her. The pain has two other characters besides its intensity; it is widely distributed, shooting up the neck, or behind to the back, and particularly to the scapula, and often down the arm; and it may be traced to the middle or anterior branches of the intercostal nerves, which are painful on the slightest pressure, the filaments of the painful nerve or nerves being distributed to the indurated portion of the breast; the pain is also paroxysmal, and it may pass from one breast to the other as an alternate affection. No trace of any inflammation of the integuments can ever be discovered. The general health is much disturbed, and the nervous system highly excited.

The *causes* of chronic mammary induration seem to have reference to functional derangements of the generative organs, but which may be of an opposite character; amenorrhœa, menorrhagia, dysmenorrhœa, or commonly profuse leucorrhœa. Unmarried women, between twenty-five and forty years of age, are most subject to these indurations; and of the married, sterile women are far more frequently affected.

Treatment is chiefly constitutional; tonics, such as iron, quinine, the mineral acids, and occasionally sedatives, have the most beneficial influence, coupled with the hygienic regimen of hysteria. Menstruation may perhaps be rectified by remedies which directly regulate that function. Of topical applications, evaporating lotions and sedative ointments are of some palliative use in relieving pain; and when the breast will bear pressure, simple strapping, or with emplastrum ammoniaci cum hydrargyro, may aid in dispersing the induration.

Irritable Mamma.—A condition of hyperæsthesia or exalted sensibility of the skin covering the breast, as well as of the gland itself, is not an uncommon affection. The breast is somewhat enlarged, firm, and conical, the nipple swollen, and the skin generally reddened. But the *pain* is the most prominent symptom, it being excited by the slightest touch, by the gentlest contact of the dress, or even by exposure to cool air. It is very widely distributed, and paroxysmal, alternating possibly from one breast to the other. The pain having a neuralgic character, and being unconnected with any structural disease of the gland, this mammary affection has also received the name of *mastodynia*. But it is of an hysterical nature, and often associated with a similar constitutional condition.

Young girls are more subject to this affection than women above the age of twenty-five; and it seems to be of uterine origin, but is probably induced by depraved habits.

The *treatment* is similar to that of chronic induration of the mamma.

Hypertrophy.—Simply an overgrowth of the gland itself, is a very rare modification of the nutrition of this organ. The size attained may be enormous; the two overgrown breasts being a perfect burden and misery to the individual.

Hypertrophy of the breast occurs in two forms, presenting a very different appearance: the large, firm, globular breast, with tense, over-spread integument; and the large, flaccid, pendulous breast, with shrivelled, wrinkled integument, the component masses of the gland having a loose connection, and the nipple small, although the areola is of larger area than usual. Occasionally, the latter form of hypertrophy is associated with a new growth—an adenocele. The enlargement may be *acute*,—progressing rapidly, and attended with heat and painful tension of the breast; or, having a *chronic* character, it makes slow progress, and occasions only mechanical inconvenience from the bulk and weight of the organ. One or both breasts may be affected, at the same time, or in succession.

The *cause* of this mammary hypertrophy seems referable to uterine derangement. It commences soon after puberty, or in early adult life; in single as well as in married women, and menstruation is generally more or less deranged. But overgrowth, thus apparently excited by the commencement of uterine life, is quite distinct from a merely functional enlargement of the organ associated with amenorrhœa.

No *treatment* has much control over this condition. either in arresting its progress or promoting its reduction. The preparations of iodine may be tried, locally and internally, and the special medicinal agents with hygienic measures which influence the catamenial function. Compression, by uniform strapping, will perhaps aid the medicinal treatment. Amputation has been resorted to in extreme cases, and after the removal of one breast the other has much diminished.

Hypertrophy of the *Fat* around the Mammary gland is occasionally seen; the breast thus attaining possibly to an enormous size. In one such case, which my colleague Dr. Cockle showed me, the fatty breasts of a young woman, aged nineteen, weighed each about eleven pounds. But the tumour of the fatty breast is evidently *continuous* with the fat *around;* and this is its main diagnostic point of distinction from hypertrophy of the gland itself.

Treatment here also is of little avail. Liquor potassæ in large doses, as originally recommended by Sir B. Brodie for fatty tumour, may have some beneficial influence.

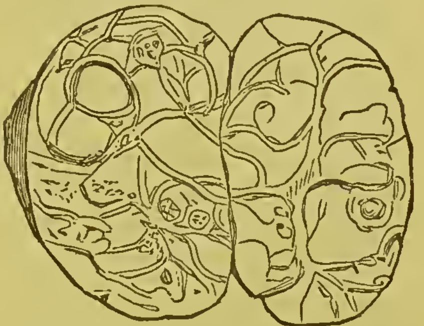
ATROPHY, or wasting of the gland-tissue of the breast, commonly takes place as the procreative function ceases in advancing life. The lactiferous ducts remain, and sometimes contain a tenacious mucus. The gland, otherwise, is very generally replaced by fat; thus presenting the outward form of the organ. In extreme atrophy of the breast, as found in old women, the arteries are not unfrequently converted into bony tubes; a degeneration of these vessels, of which specimens may be seen in the Museum of the Royal College of Surgeons, 2811, 2812; and one in Guy's Museum.

Occasionally, in early life, atrophy occurs; the gland not enlarging during pregnancy, nor secreting any milk after parturition. Prolonged lactation, and its rapid repetition, have an atrophying effect; and sometimes weaning is followed by shrinking of the gland-tissue, so that scarcely any breast remains; the gland, however, resumes its size and secretory power, even more perfectly than in full-breasted women, during a subsequent pregnancy.

A new growth, as an adenocele, forming in the breast, is often accompanied with wasting of the organ; and which may thus be almost replaced by the growth.

TUMOURS.—(1.) ADENOCELE OR ADENOID TUMOUR.—So named by Velpeau, this growth is the Chronic mammary tumour of Sir A. Cooper, Sero-cystic sarcoma of Sir B. Brodie, Mammary glandular tumour of Paget, or partial Hypertrophy of the glandular structure, as designated by Lebert. This most common form of breast-tumour is encapsuled and finely lobulated; its section has a bluish or greenish-white colour, which assumes a rosy tint on exposure to the air, and pressure of the cut surface exhibits drops of thick creamy fluid, consisting chiefly of epithelium. The tissue of this tumour closely resembles that of the gland itself; of which organ it might therefore be termed a *partial* hypertrophy or overgrowth, but as an encapsuled or *discontinuous* formation, it must be regarded as a new growth.

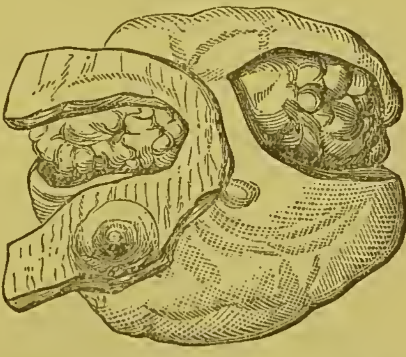
Fig. 761.*



Two *varieties* of structure—according to Mr. Birkett—may be recognized: *fibrous* adenocele, consisting of densely compact lactiferous ducts (Fig. 761), perhaps containing a milky secretion; and *cystic* adenocele, the cysts proliferous of glandular tissue from their interior, and containing a yellowish, transparent, serous fluid, afterwards dark and opaque. The cyst may be either a new formation, or result from the dilatation of lactiferous ducts, as Sir B. Brodie originally described their origin in sero-cystic disease of the breast. These two modifications of cystic adenocele differ in their origin, rather than structurally.

Symptoms.—Adenocele usually commences as a small, hard, granular, circumscribed, and painless or scarcely tender, nodule or lump; situated upon the cutaneous surface of the breast, or at its border, in its substance, or behind it. When superficial, this lump is isolated and movable under the skin; but when imbedded or behind the gland, these characters are indistinct or wanting. With an increasing size of the growth, the gland itself becomes atrophied. More than one such lump, or many, may possibly be developed, varying in size from half an inch to two or three inches. Both breasts seem equally liable to this affection, and both may be affected, though rarely.

Fig. 762.†



Cystic adenocele is distinguished by fluctuation, more or less perceptible, according to the superficial or deep situation of the growth; this character gradually disappears, as the cyst or cysts become solid, in part or entirely, owing to proliferous growths occupying their cavities more or less completely. (Fig. 762.) The skin stretching over the tumour, usually accommodates itself to increasing distension, without ulceration ensuing; sometimes, however, the skin becomes involved, and a fungoid growth protrudes externally, or a peculiar ulcer is presented, the edges of which are thin and lie flat upon the intra-capsular growth, being neither inverted nor everted, nor adherent thereto.

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* Roy. Coll. Surg. Mus., 2779 B. Mammary glandular tumour. (J. Birkett.)
† Roy. Coll. Surg. Mus., 2763 A. Proliferous cysts in breast. (Dr. Masfen.)

Causes.—No age is exempt from adenocele; it may commence about puberty, or subsequently, and most frequently at the stage of passive maturity of the breast, between twenty and thirty years of age. Single women seem most liable; and of married women, it occurs more often in those who have borne children, but rarely during pregnancy. External injury, as a blow, is now and then, apparently, the exciting cause of adenocele.

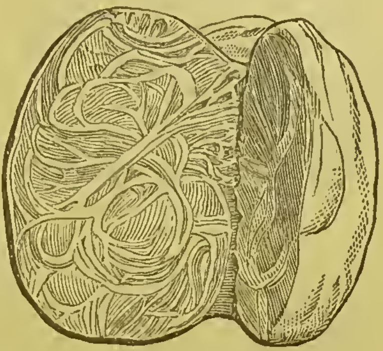
Course and Terminations.—Adenocele grows with a varying rate of progress; the originally solid and fibrous form enlarges slowly, the cystic form increases more rapidly; and either variety may attain a large or even enormous size, and a weight of many pounds. The general health remains unimpaired, excepting when a fungoid growth reduces it by continued discharge. Sometimes the tumour remains stationary, and occasionally it disappears. After removal, it seldom reappears; the fibrous variety very rarely, the cystic variety less unfrequently; and youth confers a decided immunity to recurrence, no return having ever been met with, by Mr. Birkett, when the tumour had originated before thirty years of age. Recurring adenocele may alternate from fibrous to cystic, and a third tumour return in the fibrous form of growth.

The *diagnosis* of adenoid tumour from other tumours of the breast, must be determined by reference to the *whole* of its pathology; in respect to the characters of the tumour, its causes, course, and terminations. The points of distinction between adenoid and cancer of the breast are most important. They are mainly the absence generally of any implication of surrounding parts by infiltration; as of the skin, with retraction of the nipple, and ulceration of the integument over the tumour, and never any enlargement of the axillary or other neighbouring lymphatic glands; the general health also remaining unaffected. *Cystic* adenocele more apparently resembles cystic cancer, and particularly when the growth has advanced to the condition it occasionally assumes, that of a protruding fungoid mass. But here, again, the absence of any contamination of the neighbouring lymphatics, and of constitutional cachexia, are the turning-points of distinction.

Treatment.—*Excision* of the tumour is the only certain cure. An incision is made over the lump, laying open its capsule, and the growth is then easily enucleated with the handle of the scalpel; thus sparing the mammary gland, and possibly without cutting it. The removal of a large tumour may necessitate excision of the gland as well. Not only is recurrence very uncommon, but the result of operation in relation to life is generally successful. After fifty operations, Velpeau lost not one patient. Two deaths occurred in Lebert's experience, one from pneumonia, the other from erysipelas,—an accidental cause. *Absorption* of an adenoid tumour is a rare event in nature, and but little under the influence of any known local applications or general treatment. The preparations of iodine and of bromine, in the form of ointment and taken internally, have been recommended, as having some effect. Mr. Ure—an accurate therapeutic observer—recommends the bichloride of mercury, in doses from the sixteenth to the eighth of a grain, and also the tribasic phosphate of soda, in half-drachm doses. Compression, by means of Arnott's slack air-cushion, is said to have proved especially serviceable, in promoting absorption.

(2.) Fibrous Tumour of the breast is described by some authors, and also its *recurring fibroid* variety. Both these growths are rare; but the specimen here represented in section (Fig. 763) would seem to be a genuine fibrous tumour in the mammary gland. Probably, some such tumours have been fibrous adenocele. Their pathology and treatment by excision require no special notice.

Fig. 763.*



Neuroma is occasionally developed on the cutaneous nerve-filaments, or on those within the substance of the breast. It, also, presents nothing peculiar in connection with this particular organ, whether as to its pathology or removal by operation.

(3.) Fatty Tumour, as a new growth, has been found on the breast, within the gland, or behind it; a condition distinct from fatty hypertrophy of the breast, which is simply an overgrowth of the fat surrounding the gland. The diagnosis will always be difficult, but removal of the mass is the only cure.

Remarkable cases are recorded. Sir A. Cooper removed a tumour of more than fourteen pounds weight; Sir B. Brodie relates another case in his "Lectures on Pathology and Surgery;" Warren excised a tumour of eight pounds; and Mr. Roper, of Croydon, sent to the Museum of Guy's Hospital (prep. 2300^{50}) a fatty tumour, measuring twenty-three inches around its largest circumference, which had been growing in the side of the mammary gland for fifty-eight years; it was first noticed by the woman in her thirtieth year, and she died with it at the age of eighty-seven years. In the centre of the mass there was an irregularly shaped piece of bone.

(4.) Cartilaginous and osteoid tumours are extremely uncommon. Their firm, lobulated character is similar to that of such tumours in other parts; and the treatment is excision.

Sir A. Cooper relates an instance of tumour, partly resembling the cartilage of a young subject, and partly ossific, which had been growing in the breast of a woman for fourteen years; her age being thirty-two. Professor J. Müller also notices an instance of cartilaginous tumour in the mammary gland; while he adds three other cases of this species of growth,—in one the parotid gland was the seat, and in two, the testicle.

(5.) Cysts, and Cystic-tumours.—Cysts—single or unilocular, and multiple or compound, and having various fluid or solid contents,—as proliferous cysts—are severally liable to form in the mammary gland; or they may be associated with, and imbedded in, other species of new growth,—constituting cystic-tumours, and of different kinds, as cystic adenocele and cystic cancers.

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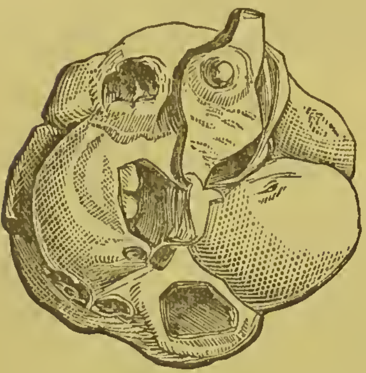
* Roy. Coll. Surg. Mus., 2776 a. Fibrous tumour of the breast. (Sir Stephen Hammick.)

The origin of these cysts, and their contents, are the principal grounds of pathological distinction.

(*a.*) *Sero-cysts.*—Single or multiple, thin-walled, and containing a clear, colourless, or pale yellow-tinted fluid, of serous character and never tenacious. No coagulation is caused either by heat or nitric acid. These cysts originate either as new formations, or possibly from dilatation of lactiferous ducts (Fig. 764), with which they may communicate or appear as perfectly closed and independent cysts.

FIG. 764.*



(*b.*) *Duct-cysts,*—perfectly closed or communicating with a duct, and containing mucoid secretion; hence named also *mucous* cysts of the breast.

(*c.*) *Galactocele* or *milk-cysts,*—produced by dilatation of a lactiferous duct or a sinus from obstruction, or by rupture of the duct, and escape of the milk into the surrounding connective tissue. As a cyst-formation incident to suckling, and occurring, therefore, only during the period of lactation, it is rather a rare affection. The little tumour—appearing sometimes as an oblong, fluctuating tube, near the nipple—may enlarge perceptibly every time the infant sucks, and thus increase rapidly; or it may remain almost stationary. The serum of the milk accumulated undergoes absorption, while the more solid fatty matter and earthy salts are deposited, causing the swelling to decrease and become firmer or quite hard, unlike a cyst wall; or the deposit may take the form of a lacteal *calculus.*

(*d.*) *Hydatid cysts* are occasionally met with in the breast. Mr. Birkett verified two such cases; one in the practice of Mr. B. Cooper, and the other in that of Mr. Cooper Forster. Another instance is recorded by Mr. Mitchell Henry, as having occurred in a woman twenty-eight years of age, and whose breast had been thus affected for a period of five years.

SYMPTOMS.—Certain characters are common to all cysts and cystic-tumours in the breast. A *single* cyst presents a globular tumour, having an elastic tension or fluctuation; more or less perceptible according to the superficial or deep situation of the cyst, and the thickness of its walls. *Multiple* or compound cysts form an irregularly lobulated tumour, otherwise having the consistence of a single cyst. Cystic-*tumour* resembles either of these conditions, in proportion to the cystic nature of the tumour; but associated also with a solid mass, bedding or enclosing the cyst or cysts.

Cysts are not essentially painful; they may become tender, owing to inflammatory action, or in nervous subjects. The skin is unaffected, excepting in the fungating tumour of proliferous cysts; and then the neighbouring lymphatic glands remain uncontaminated, and the general health is unreduced by any cachectic blood-condition. By these two particulars at least, cysts and cystic-tumours, in common with all other non-malignant growths, are distinguished from Cancer. In all doubtful cases, and many will be dubious, the diagnosis should be determined by an exploring puncture and examination of the exuded cyst-contents, before resorting to any curative operation. Hydatid cysts are distinguished by the presence of echinococci,—a species of parasite which is fully described in my "Principles of Surgery."

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* Roy. Coll. Surg. Mus., 2759 A. Cystic tumour of breast. (Sir W. Fergusson.)

TREATMENT.—*Absorption* of the contents of a cyst can sometimes be effected by the mere application of stimulating embrocations. Sir B. Brodie recommends, as having proved successful, a lotion consisting of equal parts of camphorated spirit and weak spirit, with about one-third of liquor plumbi. This must be applied on a piece of flannel, once folded, over the tumour, and renewed six or eight times in the day and night until the skin becomes inflamed; then desisting for two or three days, and again using it. Three or four weeks or some months elapse before a cure is thus effected. On the same principle, iodine paint or blistering may be curative. *Puncturing* the cyst, followed by pressure, may obliterate the cavity by adhesive inflammation; or the introduction of a tent of lint will induce suppuration, and granulation from the bottom. *Excision*, by carefully dissecting out the cyst, is not unfrequently the best or only method of treatment; or it may be necessary to remove the gland, partially or wholly. Partial excision of the gland is apt to favour a recurrence of the cystic growth, in the remaining portion of the organ; but its entire removal is occasionally succeeded by cystic disease, or perhaps a cancerous affection of the cicatrix. Hydatid cysts, when completely extirpated, are not apt to return.

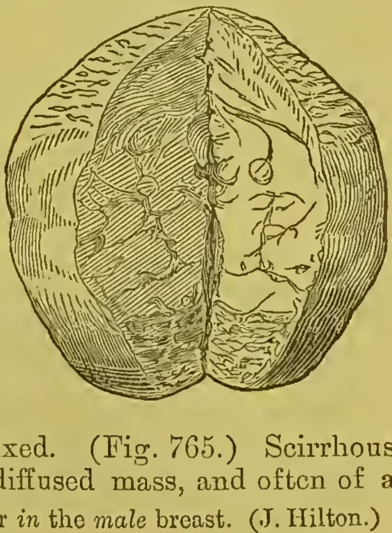
(6.) CANCER.—The breast is peculiarly liable to be the seat of primary cancer: scirrhus, very commonly; encephaloid, occasionally; colloid, rarely.

The disease appears either in the form of an infiltrating growth, or as a circumscribed or tuberous growth; or, it may be cystiform, associated with a cyst or cysts.

Scirrhus.—The descriptions usually given in surgical works of the pathology and diagnostic characters of Scirrhous Cancer are mainly taken from scirrhus of the breast, it being the most typical illustration of this species of Cancer. As such, the general pathology of Cancer may be advantageously referred to, in Part I.; while the more specially important features only of the disease, as affecting the breast, will here be noticed.

It may appear in the form of an intra-mammary tumour, or as infiltrating the whole organ, or upon its surface or circumference; or as affecting the nipple, or the skin. Commencing, commonly, as a *circumscribed* tumour, or lump, of small size, about that of a Spanish nut, hard and movable; it occasions little or no pain, and may remain unnoticed. Increasing in size slowly, this nodule acquires a granular or finely lobulated character, and is more fixed. (Fig. 765.) Scirrhous *infiltration* of the gland commences as a diffused mass, and often of a

FIG. 765.*



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* Roy. Coll. Surg. Mus., 2791 A. Scirrhous cancer *in* the *male* breast. (J. Hilton.)

somewhat square shape; hard and irregular, and soon contracting adhesions, it becomes fixed. Atrophy of the glandular structure sometimes accompanies the development of the cancer.

Cysts are liable to form in connection with the scirrhous growth, constituting a cystic cancerous tumour; which is thus rendered more irregularly lobulated, and partly solid, partly fluctuating more or less perceptibly, under pressure with the fingers.

The surrounding parts become involved, and generally the tumour is the seat of pain, perhaps severe; and which is variously described by patients, as dull and aching, shooting or stabbing, burning, etc. These terms express the different kind and degree of pain experienced as the tumour progresses to ulceration; the burning or scalding sensation supervening after the lancinating or the heavy pains in the earlier stage of the disease. But usually during the first year, at least, schirrous cancer of the breast is painless, except perhaps there may be slight twinges occasionally, or after handling the tumour; subsequently, the pain—having the varying characters mentioned—is aggravated in proportion to the rapidity of growth, or during any attack of inflammation or sloughing. The gland acquires adhesion to the pectoral muscle, and to the skin over the tumour, the integument getting bound down with some dimpling or puckering (Fig. 766), or having a brawny character, and a glazed or greasy appearance with the pores enlarged; the nipple is often drawn in by the adherent and contracting gland—presenting the appearance of retracted nipple. (See Fig. 766.) But this condition is not peculiar to cancer. Reddish-brown discolouration of the integument, at some tightly adherent part, is followed by the formation of a crack or fissure, which scabs over, while ulceration proceeds underneath the scab. Scirrhous ulcer is at length formed, having the ordinary characteristic

FIG. 766.*

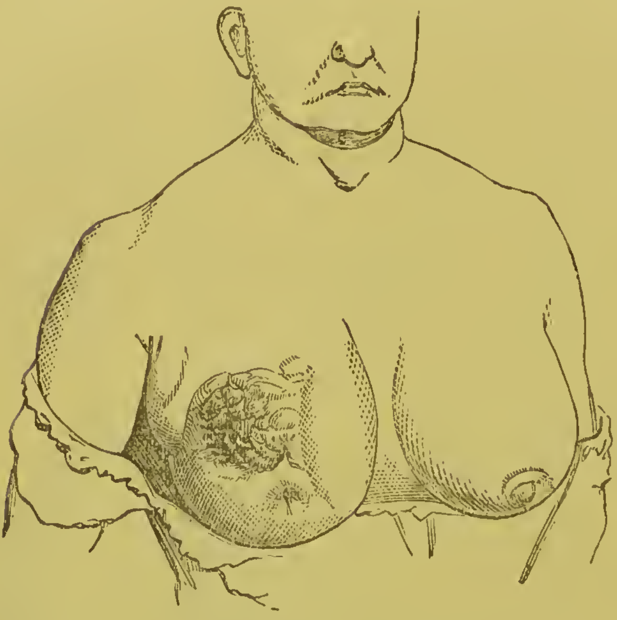
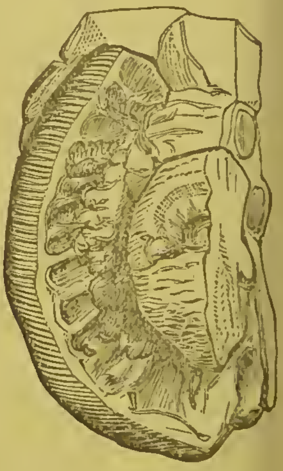


FIG. 767.†



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* Royal Free Hospital. (Author.)

† Roy. Coll. Surg. Mus., 2792. Scirrhous cancer of breast: showing deeply retracted nipple, with adhesion of the surrounding skin; circumferential ulceration, invading the pectoral muscle; and the mass had become adherent to the ribs. (Sir A. Cooper.)

appearances; hard, thickened, and everted edges, around an irregular chasm (Fig. 767), the surface of which has a greyish-green colour, and discharges foul purulent matter. Or, instead of commencing in the adherent integument, and getting deeper, ulceration may begin in the substance of the tumour, by softening and disintegration, and thus come to the surface with discharge. In either way, an ulcer is formed; but, while a superficial ulcer has no specific characters, the deep cavity presents a scirrhous ulcer. This ulcer may remain nearly stationary for months or years; or increase rapidly by sloughing; or throw up large fungous granulations and heal by an imperfect cicatrization. But the progress of the disease, thus hesitating and interrupted, goes on. The ordinary appearances may be varied, occasionally, by attacks of acute inflammation, hæmorrhages from the ulcerating surface, or œdema consequent on obstruction of the veins or the lymphatics. The axillary lymphatic glands sooner or later become enlarged and indurated, or assume the form of an agglomerated bunch, adhesion takes place, and they undergo the further course of breast-cancer. In an advanced and extreme condition, the mammary gland and axillary glands form almost one continuous matted and adherent mass, extending through the cellular texture, the lymphatics, and the skin of the breast and axilla; presenting a sort of cuirass—the cancer *en cuirasse* of French authors—and which is accompanied with much œdema of the arm. The supraclavicular and cervical glands may also be implicated.

During the course of the disease, constitutional cachexia sets in, usually when the cancer begins to acquire adhesions, particularly to the skin; and both the local and constitutional infection then proceed almost *pari passu*.

The deeper parts, and remote organs, may ultimately become the seat of *secondary* cancer. The ribs and intercostal muscles are affected more by the direct infiltration of cancer, giving rise to pleurisy, dyspnœa, and hydrothorax; but cancer may appear in the lungs, or in the bones, and result in fracture, or in the liver or uterus, and possibly escape detection during life. Exhaustion, consequent on prolonged discharge and the constitutional infection, is perhaps the most frequent cause of death.

Scirrhus commencing in the *skin* of the breast, appears in the nipple, or as a tubercle, situated usually towards the axillary border of the breast. Spreading inwards to the gland, the course of the disease is the same, but it probably will have a more restricted range.

In rare instances, scirrhus of the breast undergoes arrest of development, and the tumour withers or becomes atrophied; and sometimes an ulcerated cancer may cicatrize and remain healed. But it is extremely doubtful whether there is a single instance of permanent recovery.

Encephaloid begins either in the substance of the gland, or occasionally in the immediate neighbourhood. It appears as a circumscribed, globular tumour, of soft consistence, rather largely lobulated, and rapidly increasing in size. The skin is distended before the enlarging growth, and does not so readily become adherent, but presents a largely open network of veins. By its physical characters, the tumour might be mistaken for compound cysts; in that case, however, the skin retains a passive appearance. Sometimes the integument soon becomes inflamed and œdematous, and then the tumour simulates the characters of an abscess. But the breast rapidly acquires a remarkable change of form, becoming conical and prominent; and the integument over the most projecting part, assuming a purple hue, sloughs and forms a circular ulcer, through which the encephaloid growth protrudes as a fungoid mass, of a greyish or bloody colour, accompanied with a foul, purulent, and bloody discharge. (Fig. 768.) Portions of this mass disintegrating and separating, further protrusion from within takes place, and still maintains the fungous mass; but rarely, the whole tumour thus sloughs out, and cicatrization results. The lymphatic glands are involved, although less readily than in scirrhus of the breast; and the constitutional cachexy is less marked, or absent.

FIG. 768.*

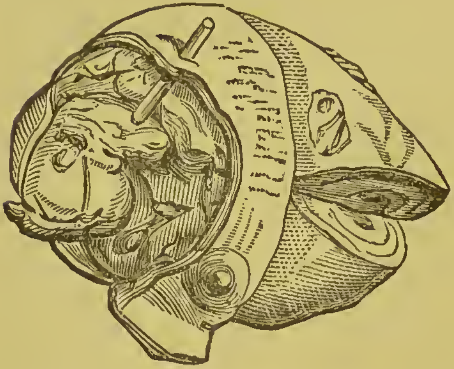
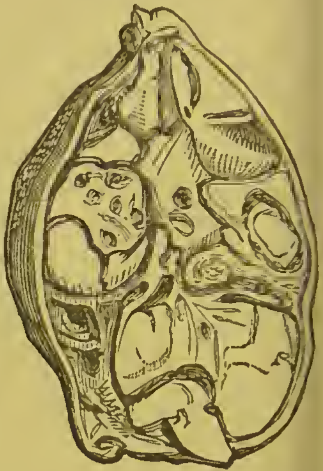
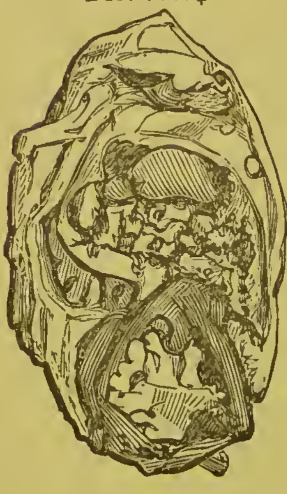


FIG. 769.†



On removing an encephaloid cancer of the breast, the section of the tumour exhibits the characteristic brain-like appearance; the medullary cancer-substance being located within a fibrous stroma (Fig. 769), and having the usual whitish or blood-mixed colour, and soft consistence.

FIG. 770.‡



Colloid.—This rare kind of cancer of the breast, consisting of gelatinous substance, loculated by a delicate fibrous matrix (Fig. 770), forms a tumour of a somewhat tense and elastic character,—not very distinctive. Mr. Erichsen removed one such tumour from the breast; it was non-adherent, and had attained the weight of six pounds, after growing for five years. Mr. Birkett has seen two examples, in both of which the nature of the tumour could not be identified, when in the breast. Isolated centres of the growth are disseminated freely around the principal mass, an important pathological condition with reference to the operation of excision for complete removal of the tumour.

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* Roy. Coll. Surg. Mus., 2795 A. (J. Birkett.)

† Ibid., 2795. Encephaloid or medullary cancer of the breast—section, showing locular arrangement of cancer-substance, enclosed within a fibro-cellular matrix. The tumour was only slightly vascular, the vessels being confined chiefly to the matrix. A few cysts are scattered irregularly in its substance. (Sir A. Cooper.)

‡ Ibid., 2796 B. Colloid cancer of the breast; the colloid substance being contained within a slight, open, fibrous matrix. (Thomas Bryant.)

This kind of cancer is usually associated with scirrhus or encephaloid.

The *causative* relation of age and uterine activity to cancer of the breast, is diagnostically important. From the fortieth to the fiftieth year, or the fifth decade of life, is the age most subject to this disease, as affecting the breast. Of 158 cases collected by Paget and 62 by Lebert, the disease appeared in 22 only before thirty years of age. Before twenty years of age, Mr. Birkett has never seen a case. But Mr. Lyford and Mr. B. Cooper each record an instance; the one at eight years, the other at thirteen years of age; and in the Museum of St. Bartholomew's Hospital there is a specimen removed from a girl aged sixteen years.

The following interesting table gives the results of Mr. Birkett's experience in 458 cases, between the ages of 20 and 100 years, in decennial periods :—

Age from 20 to 30 years	19 cases.
„ 30 „ 40 „	100 „
„ 40 „ 50 „	193 „
„ 50 „ 60 „	97 „
„ 60 „ 70 „	34 „
„ 70 „ 80 „	6 „
„ 80 „ 90 „	7 „
„ 90 „ 100 „	2 „
	458 „

Unmarried women are said to be more prone to cancer of the breast than the married, and sterile women rather than those who are prolific. The fallacy of these notions is shown by Mr. Birkett by an analysis of 100 cases ; 86 were married, and 14 only single. Of the 86 married women, 73 were prolific, 4 had aborted, and 9 only were sterile. In relation to lactation, there does not seem to be any marked connection between the imperfect performance of this function and the subsequent development of cancer; but it is a notable fact that the disease is very rarely developed during pregnancy or suckling.

Hereditary predisposition does not seem to have much influence in the production of breast-cancer. From collections of cases by Paget and Lebert, it appears that about one in six may be referable to some hereditary tendency. The general health at the commencement of the disease is apparently good in the great majority of cases; and it is uncertain how far any causative influence can be attributed to depressive mental conditions, such as grief, or to temperament or occupation.

The origin of the disease is popularly attributed to some external injury, as a blow, or the pressure of a stay-bone; there is abundant evidence to justify this belief, and that any injury to the breast, however slight in itself, may be the exciting cause of cancer-production. But, of ninety-one patients in Paget's series, only sixteen, or less than one in six, attributed the formation of hard cancer to injury, or any such local cause.

Prognosis.—The average duration of life is about three years, or less than four ; or rather more than four years (Paget); and scirrhus is less rapid in its course than encephaloid ; the rare form, colloid, growing slowly. Scirrhus also proceeds more slowly in old people; there are many instances where the disease has existed for ten or twelve years, and in one instance, as related by Sir B. Brodie, for twenty-five years. Encephaloid proceeds most rapidly in young and constitutionally healthy women. Generally, it may be stated that the younger and more healthy the patient, and rapid the course of the disease, the prognosis should be proportionately unfavourable.

Treatment.—The hygienic and medicinal treatment of cancer of the breast, and its removal by operation, whether by excision or some other method, are two principles of treatment; each of which has its advocates, and to the exclusion of the other and opposite principle. Some Surgeons would treat all cases medicinally, and according to the natural course of the disease; others would, in all cases, extirpate the disease by operation. It is unnecessary to point to illustrations of these opposite views in the practice of Surgeons, present or past.

The truth, as in many other matters, lies between these two extreme rules of treatment. The intermediate plan has reference to the individual case, both with regard to the local condition of the cancer and the constitutional power of the patient.

Assuming a case to be thus ineligible for operation, the following plan of treatment should be pursued. The disease being a perversion of nutrition as manifested by a reproductive growth, the *pathological* and rational indication of treatment remedially would be, to rectify this deviation of the nutritive process so as to arrest the growth of cancer, and possibly lead to a predominance of the reverse process,—absorption, and thence the eventual disappearance of the tumour. Any such control over the formative or vital changes in nutrition, or over the chemical changes of the nutritive material—any such mode of arresting cancer-growth, is quite beyond our present knowledge of physiology and pathology, in respect to this process. It only remains, therefore, for the practitioner to avail himself of such knowledge as *experience* has supplied. A generally nutritious diet, as the phrase goes, will suggest the object to be attained, in the selection of dietetic resources; but it is absolutely necessary to watch and discover, in each case, what particular articles of diet are most suitable for the improvement of the patient's general nutrition, and may have any marked influence on the progress of the disease. Anodynes, applied topically and administered internally, not only relieve the often severe and prolonged suffering incident to this disease; but these medicinal agents are important adjuncts to our dietetic resources, in procuring sleep and repose of the nervous system, requisite for a more healthy nutrition. Thus, narcotics, and in particular the preparations of opium, are highly advantageous; while conium ointment is, I think, the most soothing topical anodyne, although aconitine ointment or belladonna plaster may be equally so in some cases. The preparations of ether—sulphuric and chloric—and chlorodyne, are most efficacious for the relief of paroxysmal pains of a neuralgic character; and here quinine and iron are serviceable, as tonics. But tonics have probably a yet deeper remedial value. Iron may have some restorative influence in proportion to the cachexia, which plainly denotes a morbid blood-condition, one element of which is a diminution of the red-corpuscles. Quinine is remedial in sustaining the general circulation, and thus supplying the pabulum of an improved assimilation; while stomachic tonics, such as gentian, calumba, and humulus lupulus, aid the digestion or primary assimilation of food.

There is, therefore, apparently a running connection between these known measures,—a nourishing, well-selected diet, anodynes, and tonics, and they constitute the principal resources of the hygienic and medicinal plan of treatment, in respect to Cancer. By combined observation and judgment in the application of this plan, and by pursuing it perseveringly, doubtless many cases of scirrhus of the breast have been kept in abeyance—and life prolonged far beyond the average period of duration in this form of Cancer-growth.

Compression has been extolled as having an almost or absolute curative efficacy. Various means have been employed; the slack air-cushion of Dr. Arnott, or plasters, which, besides supporting the tumour, may have some medicinal influence in arresting its growth. But the pretensions of this method are, I believe, now renounced, and indeed any such applications are generally discarded. The arrest of a reproductive growth, as cancer, is not to be accomplished simply by mechanical repression of the tumour; nor, in the face of its inherent power of growth, can the tumour be made to undergo absorption. Any apparently successful results of this principle of treatment have been altogether exceptional; and probably, therefore, were due to other concurrent causes of cure.

Ulcerated cancer must be treated as any other open sore, according to its varying condition. Sloughing should be met by poultices, and cleansing lotions of chloride of zinc, permanganate of potash, or carbolic acid; in conjunction with sedatives, such as morphia, conium, or belladonna, to allay pain. Hæmorrhage may be restrained by the ice-bag temporarily applied, or by means of astringent powders or lotions, such as tannin or tincture of the perchloride of iron. *Œdema* of the arm, in the advanced stage of the disease, can be somewhat relieved by moderate bandaging and elevation of the limb.

Conditions favourable for operation.—In proportion to the purely local and isolated condition of the cancer, its removal is justifiable, or favourable—in relation to the prolongation of life. This local state carries with it a commensurate share of constitutional power. Hence, in the early stage of cancer, when it is as yet small and movable, without adhesions or implications of surrounding parts—either in the integument by adhesion or ulceration, or the lymphatic glands by enlargement and induration—and consequently when there is little or constitutional cachexia, the breast may be removed with the *most* favourable prospect of prolonging life. Mr. Birkett extends this principle to some degree of advancement in the progress of the disease; as even then offering an advantage, compared with allowing it to run its course. Accordingly, an operation may be undertaken with advantage when the disease has extended to the skin without infiltrating the cutaneous tissue to a wide extent, when ulceration has taken place, and even when the axillary lymphatic glands are distinctly indurated and somewhat enlarged.

Conditions unfavourable for operation.—The following general rules represent the conditions, local and constitutional, wherein the balance of advantage is clearly against operation. They are thus stated by Sir James Paget:—(1.) In well-marked chronic cancers, especially in old persons, the probability that operation will add to either the comfort or the length of life is so little, that its risk had better not be incurred. These are the cases wherein the operation may be longest survived; but also in which, without operation, life is most prolonged and least burdened. (2.) In cases where the cachexia or evident constitutional disease is more than proportionate to the local disease, the operation would too probably be fatal, in its own consequences, or by accelerating the progress of cancer in organs more important than the breast. For similar reasons, and yet more certainly, any well-grounded suspicion of internal cancer would forbid recourse to operation. (3.) If there be no weighty reasons for its performance, operation should be avoided in all patients whose general health—apart from the cancerous diathesis—would entail unusual risk; as in very feeble, very fat, over-fed, or intemperate persons; and, indeed, in any conditions which, being peculiar to individuals, would render them unfavourable subjects for other surgical operations.

The probability of cancer recurring in situ, after removal of the original growth, by operation.—This question is twofold; it relates to the proportion of recurrent cases, and as to the average period of immunity, before the return takes place. Experience shows that, in a large proportion of cases, the disease returns; generally, also, in two or three years, as Sir A. Cooper and Sir B. Brodie both observed, and with a fatal termination. But, from Mr. Baker's tables, it appears that, in forty-two per cent., cancer of the breast returns within six months after operation; and Paget's and Lebert's series of cases each show that the period of immunity is seldom extended beyond a year. This interval of freedom is not prolonged by the previously short duration of the disease; recurrence taking place generally not later after early than after delayed operations. With regard to the state of the tumour, and of the lymphatic glands at the time of operation, evidence is wanting in confirmation of two received opinions:—that return of the disease, and death, will be more certain and speedy, if the cancer be adherent to the skin, or in a state of ulceration; and, again, when the axillary lymphatic glands are involved, and removed with the cancerous breast, that recurrence and a fatal termination will be accelerated.

The probability of prolonging life, by operation.—The statistics collected by Paget, Sibley, and Baker, respectively, are here to the point. Paget states, that of 139 cases, seventy-five were not submitted to operation, and of these the average duration of life was forty-eight months. Of sixty-four operated on, the corresponding average was a little beyond fifty-two months. Sibley finds that the average duration of life in unoperated cases was about thirty-two months; whilst in those submitted to excision of the breast, it reached fifty-four months,—a relative difference still more in favour of operation. Baker's table shows that the average was forty-three months, against fifty-five months,—a relative difference more nearly corresponding to that shown by the first series of cases. But the *period of the disease*, when submitted to operation, makes a very important difference in its result. Thus, in the first two years of the disease, the proportion of deaths has been found to be much less in those operated on than in those who were left to nature and other treatment; being in the former less than eleven per cent.; in the latter more than thirty per cent. The longest duration of life in cases not operated on, was eighteen years; in those operated on, a little beyond twelve years. The *temporary relief* from suffering should, however, always be taken into account in considering the advisability of operation; and that the progress of the more rapid eases is retarded by operation.

The *comparative* advantages of *excision*, and removal by *caustic* applications, may be thus summarily stated. The one method is expeditious, attended with little suffering, and certain of removing the whole of the diseased organ; if the operation be performed sufficiently free of the disease. The treatment by caustics is tedious, attended generally with excruciating pain, and very uncertain in its operation. In comparing the results of the two methods upon the constitutional progress or local recurrence of the disease, there is not a balance of evidence in favour of either. Both are commonly followed by a return of cancer *in situ*, or its development in distant parts.

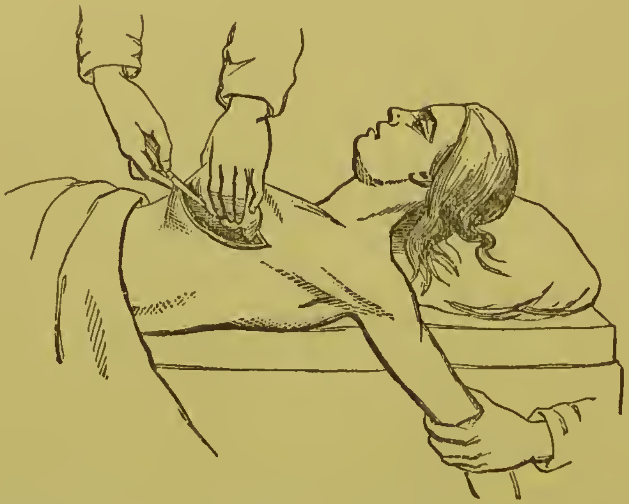
Recurrent cancer of the breast.—Cancer may return in the cicatrix, and subsequently implicate the glands; or in the glands without any previous affection of the cicatrix. As secondary cancer, the disease may reappear in some internal organ,—the lungs, bones, liver, or uterus. More rarely, the disease returns in the opposite breast. The species of recurrent growth, in any situation, is almost always the same as the primary cancer,—scirrhus. *Cicatricial* scirrhus presents itself in the form of scattered tubercles or buttons of cancer-growth; a very characteristic appearance. The period of return is uncertain; sometimes before cicatrization is completed, and having the character of a cancerous ulcer; or not until after some weeks or months of completed cicatrization, then having the tubercular form in and around the cicatrix, and the nodular growths undergoing cancerous ulceration. Recurrent cancer may, or may not, run its course more rapidly than the original growth, but it is said to be less painful and exhaustive.

The operation of excision is still justifiable, even to the third or fourth reappearance of cancer, in order to relieve suffering; provided the constitutional power of the patient seem sufficient to sustain life. I thus removed with some advantage a large tubercular cancerous cicatrix, and subsequently the whole of the axillary glands in a bunch, from a lady, whose breast I had previously completely excised; but, after she had again enjoyed a temporary respite, the disease returned a second time, in the form of a nodular shield over the pectoral muscle, and when last I heard of her she was in a dying state.

The *cure* of cancer of the breast, or in other parts, is sometimes said to be possible, probable, or certain, in some instances. Of course this question, as to the result of any case, implies a previously correct diagnosis,—that no other kind of tumour has been mistaken for cancer. Then, if by cure be meant the arrest of cancer-growth, in the natural progress of the disease, aided perhaps by local and constitutional treatment, undoubtedly there are rare such instances,—the tumour becoming quiescent, perhaps disappearing, and even in the stage of ulceration, cicatrization has taken place, and the ulcer remained healed. But this apparent termination of the disease is only temporary, although the period of cessation, in scirrhus for example, may continue for months or years,—to ten or twelve years, and life has been prolonged to eighteen or twenty-five years. Yet there is probably no single authentic case of permanent recovery; cancer-growth has at length reappeared in the part originally affected, or as secondary cancer in some other part or internal organ. Inflammation, and its destructive consequences, suppuration and sloughing, have also proved curative, for a time, in rarely exceptional cases. If, again, by cure be understood the non-recurrence of cancer after its apparently entire removal by operation, such true cure may not be impossible, but it is highly improbable in a single instance. Extirpation, therefore, cannot be regarded as a final remedy for the disease. The reasons which justify recourse to operation rest upon other grounds, already explained; namely, as to the temporary relief from suffering, and the probable prolongation of life; the risk from the mortality of the operation itself, in proper cases, not exceeding six deaths per cent.

OPERATION OF AMPUTATION OF THE BREAST.—Whatever may be the disease, whether a cancerous or non-malignant tumour, removal of the breast is performed in the following manner:—The patient lying down, and chloroform having been administered, an assistant holds the arm away from the affected breast, sufficiently to put the pectoralis muscle on the stretch, and define the breast on its axillary border. The Surgeon introduces a breast-knife on the axillary aspect of the breast, and makes a semi-elliptical incision below the nipple, varying in its extent according to the size of the tumour; this incision is made first, that its course shall not be obscured by blood trickling down from above. A corresponding incision is then made above the nipple, thus including the nipple and an elliptical portion of integument. The portion removed is small compared with the size of the tumour, but the integument remaining as a bag after operation, contracts eventually so as not to be superfluous. The breast is then dissected out from below upwards, the knife being carried slopingly around the organ down to the fibres of the pectoralis, along the axillary aspect of this muscle, and thence upwards under the tumour, to meet the upper incision. (Fig. 771.) Care should be taken not to make a button-hole in the skin; a blemish which may be avoided by directing the edge of the knife towards the tumour, in detaching it from the integument, below and above.

FIG. 771.



A *cancerous* breast must be removed more extensively than when it is the seat of non-malignant tumour. The incisions should be carried so as to include any apparently affected portion of integument; and prolonged upwards towards the axilla when necessary, to allow the removal of any affected glands. In removing the tumour, the dissection should be carried wide of the disease and fairly into sound tissue around, in order to completely extirpate the diseased mass. It may be more convenient, in concluding the operation, to extend the axillary junction of the incisions, so as to reach any diseased glands; their connection with the breast will enable the Surgeon to drag them out of the axilla, when they can be readily detached by successive touches with the knife. If the glands be removed after the breast, they may be seized with artery-forceps or a vulsellum, and dissected out. The operation-wound should be carefully examined, to see that no part of the gland or affected portion of cellular texture remain behind.

Non-malignant tumour of any kind, and which does not involve the whole of the mammary gland, may admit of removal by suitable incisions, without including the nipple. In several such cases of mammary tumours, I have thus succeeded in preserving a comely breast.

Arteries bleeding must be tied or twisted; they are principally situated towards the axillary aspect of the wound. Sometimes, in removing the tumour, it may be desirable to secure the vessels as they are divided, in order to prevent the loss of blood when the patient was previously exhausted, and to enable the operator to see his way in applying the knife, when the tumour is unusually large and vascular. At the same time, the subclavian artery should be compressed by an assistant. If the tumour removed be non-malignant, only one or two vessels may have to be secured; removal of a malignant tumour will probably necessitate the ligature or torsion of numerous and large-sized arterial branches, which are supplied to this more active form of growth; and venous hæmorrhage may require control. Cold ablution will generally arrest any oozing hæmorrhage, arterial or venous. The lips of the wound should then be brought together by points of fine wire suture; and the support of two or three strips of plaster, with a compress of lint and a bandage, will prevent any subcutaneous hæmorrhage and bagging in the loose integument. Primary union sometimes takes place, and in a few days; but more frequently this union is spurious, and the wound opens up partially at least, with suppuration, and heals by granulation. Secondary hæmorrhage may necessitate a reopening of the wound, and the application of ligatures. Eventually a sound, puckered cicatrix is presented; or perhaps a recurrent form of growth, when the original tumour was malignant.

Functional Disorders of the Breast.—(1.) *Abnormal secretion of Milk.*—This disorder relates to the age of the woman, and is unassociated with pregnancy. The breasts of old women have been known to secrete milk; and it has formed at a very early age,—eight years. In some women, reputed virgins, the breasts have secreted a troublesome quantity of milk; and I have seen the lacteal secretion excited in a woman nearly fifty years of age, after sexual intercourse; she having borne eleven children.

(2.) *Excessive lacteal secretion*, or *Galactorrhœa.*—The milk may be constantly dribbling away; or the secretion may continue after weaning suddenly, or at the termination of the proper period. This undue secretion is suppressed most effectually by the application of the extract of belladonna, spread thickly on lint, and placed over the whole breast or both breasts. Sedatives and tonics have also some degree of beneficial influence in arresting the secretion.

(3.) *Deficient lacteal secretion*, or *Agalactia*, depends either upon an organic imperfection of the gland, or on constitutional causes. The secretion will probably be excited by the application of the leaves of the castor-oil plant to the breast, by warmth and moisture, and by the stimulus of the act of suckling.

(4.) *Congestion with Milk.*—This state seems to depend on a secretion of the more solid constituents of the milk, without the serous; thus favouring an accumulation of thick milk in the lactiferous ducts, instead of the escape of the secretion being facilitated by a due admixture of fluid. The breast acquires an enormous size, and a stony hardness, resembling scirrhus. But the sudden appearance of this large tumour, and its occurrence during lactation, probably when this function first commences after parturition, are sufficiently diagnostic.

Lacteal congestion of the breast proceeds very slowly and generally terminates in inflammation and abscess.

This affection is usually confined to one breast; and the gland having regained a healthy condition, performs its function healthily after a subsequent parturition.

The *treatment* consists in strapping, and the application of an ointment of iodide of potassium or iodide of lead; gentle aperients and tonics.

Diseases of the Male Breast.—The mammary gland in the male exists in a rudimentary state; occasionally only some development of glandular structure taking place. Soon after birth, the organ becomes tumid, and a slight secretion forms within the ducts. This naturally ceases, or may require repressive treatment. At puberty, the gland again enlarges, is painful for a few days, and then subsides. Irritation at this time may induce inflammation and abscess. Or, in the adult, some slight wound or chafe near the nipple will, perhaps, give rise to abscess, of which I have seen two instances; in one the axillary glands became enlarged, and threatened to suppurate. A remarkable sexual excitement may also occur in such cases.

Hypertrophy of one or both breasts is sometimes produced in men of delicate constitution; the glands enlarging sufficiently to resemble the bosoms of young girls. *Treatment* of any such natural conformation will scarcely succeed in reducing this annoyance.

Tumours, of the same species as those in the female breast, occasionally form in the male breast. Cancer is the most frequent growth, and it appears generally between forty and fifty years of age. The *treatment* of morbid growths presents nothing peculiar. Amputation of the breast is performed in the same way as for the removal of the female breast, but the operation in the male is less extensive.

Anomalies of Development, in the Female and the Male Breast.—(1.) *Absence* of the Breast is recorded both by Sir A. Cooper and Froriep. Congenital deficiency of the Nipple has also been met with.

(2.) Supernumerary Breasts are of more frequent occurrence, though rare. Most frequently, one supernumerary gland has been found; sometimes, two such glands; rarely three—constituting, with the normal glands, five mammæ. The situations of an abnormal mamma are various; usually being near to the natural breast, and where four breasts have been developed, they have ranged in parallel pairs, one above the other on either side of the thorax. But an extra breast has been found in the axilla, on the back, on the abdomen, in the groin, or on the outer part of the thigh. These glands, thus oddly situated, have been known to secrete milk. Supernumerary *Nipples* also sometimes occur; two to each natural breast, both nipples communicating with the gland and passing milk. Several extra nipples have been developed on one breast.

The *male* breast is liable to similar developmental anomalies. Thus, four nipples have been seen. Deficiency of one or both nipples seems to be unknown.

THE ABDOMEN.

CHAPTER LV.

INJURIES OF ABDOMINAL PARIETES, AND VISCERA.

Injuries of the Abdomen are of almost equal concern to the Civil and Military Surgeon. Their leading practical distinctions are as follow.

Contusion of the Abdominal Parietes.—The extent of structural disorganization produced by contusion varies considerably; the abdominal muscles being lacerated possibly, while the skin remains unbroken. The ordinary appearances of Bruise are presented, in most cases, and the usual symptoms of Shock in a greater or less degree.

The *cause* of contusion may be various occasions of external violence—such as a blow or kick, or gunshot injury. Shock may either soon prove fatal or pass off; and the bruise may gradually disappear, or be succeeded by abscess, or by peritonitis and thence a fatal termination. After recovery, the abdominal wall sometimes becomes atrophied at the seat of injury, predisposing to the occurrence of ventral hernia. Rupture of the abdominal muscles is sometimes produced in the same way as contusion; or occasionally by violent straining efforts, or the force of tetanic spasm.

The *treatment* has reference to the recovery from Shock, by a moderate administration of stimulants; followed by the ordinary topical applications to a bruised part, coupled with rest. The contingencies, inflammation and its consequences, or hernia, occurring with or consequent on the abdominal contusion, must be treated in accordance with these conditions.

Wounds of the Abdominal Parietes differ in no particular from the same injuries elsewhere, and the treatment must be conducted on ordinary principles. Thus, in Military practice, the Surgeon may have to deal with wounds from a sword-cut, or a bayonet-thrust,—not penetrating the abdomen. *Gunshot* wound, limited to the abdominal wall, is not unfrequently met with; as a bullet wound passing beneath the skin around the abdomen for some distance. This injury is attended with a slight blush of inflammatory redness in the course of the ball, with indurated swelling and tenderness; resembling the cord presented by an inflamed lymphatic vessel. A peculiar fine crepitation may, perhaps, be felt under the finger, along the track of the ball; this being due to the admission of air, or as an after-symptom, arising from emphysematous sloughing. Subcutaneous gunshot wound is more often produced by a round bullet, which is easily deflected from its course, rather than by a conoidal ball, which generally penetrates in a straight line. *Treatment*, in the first instance, must have regard to the ball, which should be extracted, when it can be plainly felt and fixed under the finger; an incision being made, if necessary, for the purpose of removing the foreign body. Hæmorrhage seldom proves troublesome, unless, perhaps, when the internal mammary artery, the epigastric, or the circumflex iliac artery is wounded; and then the bleeding may be arrested by ligature or torsion, the wound being enlarged, if necessary, to reach the vessel. Peritonitis is very apt to supervene, and must be treated accordingly. This complication, and the liability to visceral injury from contusion, accounts for the greater mortality—somewhat over eight per cent.—from non-penetrating gunshot wounds of the abdomen, according to the experience of American Surgeons in the War (1861–65), as compared with the results of similar wounds of the thorax, or even of the head, when the injury is confined to the scalp.

Abscess sometimes forms in the abdominal parietes, and may spread extensively. It arises usually from contusion, the presence of a ball, or other injury; but I have seen wide-spread parietal suppuration proceed from the irritation of a foreign body—a bean, impacted in the vermiform appendix of the cæcum, which lay in contact with the abdominal wall, as if a spontaneous effort of elimination. Carbuncular abscess also I have known to occur in the abdominal wall. *Treatment* of abscess in this situation presents nothing peculiar; except that it should be opened early, lest matter burrow into the peritoneum or the pelvis. But a deep incision might afterwards induce hernial protrusion.

INJURIES IMPLICATING THE ABDOMINAL VISCERA.—The *general symptoms* of any such injury are those of Shock—severe and prolonged, coupled with the collapse arising from internal hæmorrhage. The pallidity of countenance and anxious expression, the coldness of surface, and thready, feeble pulse, are sufficiently significant symptoms. With extensive internal hæmorrhage there may be perceptible dulness on percussion.

Special symptoms proceed from injury of different abdominal viscera; they are somewhat diagnostic of the organ implicated, but depend also on the causes of such injury.

The *causes* in question are rupture from contusion, and penetrating wounds of the abdomen. *Contusion* is necessarily occasioned by severe external violence; the passage of a cart-wheel across the abdomen, or compression between the buffers of two railway carriages, known as Buffer-accidents; and in Military practice, the brushing action of a so-called wind-contusion, or the direct pounding of a spent cannon-ball. Rupture of any one of the viscera, and extensive internal hæmorrhage, are not necessarily attended with any mark of contusion or bruise, as an outward sign of this internal injury. An abundant layer of fat in the abdominal wall, combined with thick clothing, seems to form a buffer of yielding resistance, which may prevent the production of a bruise. In one such case, a stout female, who had been brutally kicked in the abdomen by her paramour, died in a few hours from collapse. I found a large collection of black clotted blood in the abdominal cavity, but not a trace of discolouration in the integument. *Penetrating* Wounds are commonly produced by a stab or a pitchfork accident; and in Military practice, by a sword-cut, or bayonet-thrust, a bullet, or other gunshot injury.

Rupture, or Penetrating Wound, of Different Viscera.—The Stomach.—The diagnostic symptoms are vomiting of blood, with, perhaps, the escape of some of the contents of the stomach in the case of a wound. But the stomach has been *ruptured*, almost completely across near the pylorus, and no blood appeared in the vomited matters. The situation and depth of a *wound* will help to determine the diagnosis. Penetrating gunshot wounds of the stomach are singularly fatal, as shown by sixty-four cases which occurred in the American War of the Rebellion; only one instance of undoubted recovery is reported.

The Bowels.—Similar symptoms are diagnostic; the passage of blood in the stools, and the escape of fæcal matter through a wound. Sometimes the intestinal contents can be found on the penetrating instrument. Extravasation of fæcal matter into the abdominal cavity is attended with instant excruciating pain, radiating over the whole abdomen from the seat of injury, and extreme collapse. But a small puncture or an incised wound of the intestine, under three lines in extent, or as thus diminished by muscular contraction, may not allow of extravasation; the mucous membrane protruding through the muscular coat and occluding the aperture, while the equable pressure of the abdominal viscera against each other further prevents any escape from an intervening wound. From elaborate experimental observations by Professor Gross, it would appear that the *direction* of a wound,—having this limited extent,—in relation to the axis of the intestine, is of no practical consequence; whether such a wound be longitudinal, transverse, or oblique. A lacerated wound of larger size may be also unattended with fæcal extravasation, the peristaltic action of the intestine being deadened. Subsequently, in any case, the speedy effusion of plastic lymph tends to close the aperture. The absence of the characteristic pain and collapse, as symptoms of feculent extravasation, is, therefore, no conclusive evidence that the bowel is neither ruptured nor wounded. Emphysema of the abdominal wall may arise from the escape of flatus through an intestinal aperture, into the subperitoneal cellular tissue. Commencing, usually, in one or the other flank, the peculiar, pitting, crepitating swelling extends forwards around the abdominal parietes, and upwards towards the axilla. This symptom is the result alike of rupture or wound. In rare instances, feculent matter, or food, extravasated from the intestine or the stomach, has become encysted, and leading to the formation of abscess, has been safely discharged externally. Thus, Archer relates a remarkable case in which, after an incised wound of the stomach, with escape of alimentary matter into the peritoneum, an abscess opened in the groin, and gave vent to portions of cabbage; the patient recovering. A ball which has lodged in the abdomen may be discharged per anum. When this happens soon after the wound, it is probable that the ball directly penetrated the intestinal canal; but as occurring some time after the injury, the ball has probably entered the canal through ulceration, or by the communication of an abscess where the foreign body had lodged outside the intestine.

Liver.—Owing to the highly vascular nature of this organ, rupture or wound of its substance is attended with copious hæmorrhage, and proportionate collapse. A bilious discharge distinguishes wound of the liver. Recovery from either injury has been known to occur in a considerable proportion of such cases; but followed often by peritonitis or hepatic abscess, and sometimes by jaundice, or, as Bernard has shown, saccharine diabetes. The *gall-bladder* alone may be the seat of injury, and rupture or wound seems to have been almost always fatal. The mortality of these injuries is much increased by additional injuries to adjoining parts; such as fractures of the ribs, or lesions of the lung, diaphragm, stomach, and other organs; or by the lodgment of a ball or portions of clothing in gunshot wound involving the liver.

The *spleen*—a fragile and highly vascular organ—is perhaps equally liable with the liver to rupture, and wound may occur; either form of injury is attended with severe internal hæmorrhage and collapse, and both are often fatal. But complete reparation may take place, as Legouest observes, in even some grave cases. Protrusion of the wounded portion of spleen has proved a favourable complication, by lessening the risk of hæmorrhage internally, and of peritonitis.

The *kidneys* are sometimes ruptured or wounded. Frequent micturition of bloody urine is the diagnostic symptom; although the secretion of urine may be suppressed by complete structural disorganization of the kidney, and thus the absence of this symptom is no assurance that the kidney is uninjured. The escape of urine through a wound will at once indicate the nature of this injury. Any injury to the kidney may induce nephritis; and when the peritoneum is implicated, urine escaping into that cavity, the case becomes almost hopeless from intense peritonitis. Otherwise, lesions of the kidney are not irrecoverable.

The pancreas has occasionally been the seat of lesion from rupture or wound, including gunshot injury; and death is liable to ensue from hæmorrhage or peritonitis; but, more frequently, the accompanying injuries to other organs are the cause of death. I am not aware of any distinctive symptoms referable to injuries of the pancreas, for no functional derangement is appreciable. Inflammation around the injured part of this organ sometimes occurs; just as a circumscribed hepatitis or splenitis may arise from wound of the liver or the spleen; or a localized traumatic pneumonia, when the lung is injured.

The *Diaphragm* is most frequently ruptured in connection with other organs; it may also be penetrated by a stab-wound, by gunshot injury, or by a fractured rib without any external wound. The visceral complication is the fatal element in these diaphragmatic injuries. Hernial protrusion of the abdominal viscera into the thoracic cavity may take place; or occlusion of the gap by the formation of a false membrane is a possibly reparative issue.

Penetrating Wounds, not involving any viscus—are distinguished simply by the absence of any symptoms of visceral complication. The escape of a small quantity of reddish serous fluid is the only positive diagnostic sign. Gentle examination with the finger will best and most safely ascertain the fact of penetration.

Protrusion of Viscera—and *with Wound of Viscera.*—The former condition is a visceral implication of dangerous character; the latter condition is positively perilous. Both owe their vital significance to the great risk of peritonitis; any extravasation of blood or the contents of certain viscera increasing this liability.

Protrusion of the stomach, intestine, mesentery, or omentum may be recognized by the appearances of the protruded mass. Its size is always large as compared with the aperture from which it emerges; and the margin of the opening constricting tho protruded portion of viscus, a neck or peduncle is formed, which is overlaid and concealed by the mass. The aperture and peduncle can be easily discovered by gently raising the protrusion with the fingers. At first of a bright red colour and glistening peritoneal aspect, the mass soon becomes dull looking and purple from congestion, and afterwards black and flaccid as gangrene supervenes.

Wound of a protruded intestine is denoted by the escape of fæcal matter and flatus; the characters of the wound also are peculiar, and vary according to its size. A puncture, or an incision two or three lines in length, is attended with eversion or prolapsus of the mucous membrane; which, closing the aperture, prevents the escape of feculent matter. An incision beyond four lines in length evinces some tendency to protrusion of the mucous membrane in the form of a lip over the margin of the cut; but thus allowing the discharge of feculent matter.

Consequences, and *Prognosis.*—All injuries of the Abdomen implicating the viscera, whether by Rupture or Wound, are apt, in some degree, to be followed by Peritonitis. Penetrating Wounds of the abdominal cavity have also this liability. But if implicating the stomach or intestine, in particular, the risk is greater; and if attended with the escape of the contents of these viscera into the peritoneal cavity, the danger reaches its maximum. On the other hand, all such injuries have a notable tendency to reparation, by primary adhesive union, and without the extravasation of intestinal or other matter. Certain remarkable cases of such reparation are on record. Thus, John Bell refers to the case of an extensive lacerated opening of the abdomen, in the person of a peasant boy who had been gored by a bull. The intestines—unwounded—protruded, and were replaced. The poor lad came the next day on foot three miles from his village, carrying in the skirts of his shirt, and in his hands, a great bundle of intestines which had again protruded; they were again returned, the wound was neatly sewed, and the patient recovered. A madman stabbed himself with eighteen deep wounds in the abdomen, with a long and sharp-pointed knife; eight of the wounds penetrated the cavity of the abdomen, and touched the stomach and intestines, as shown by the vomiting of blood and its passago by stool. Yet the man entirely recovered in two short months. In another paroxysm of madness, eighteen months afterwards, he threw himself from a high window and died upon the spot. Post-mortem examination revealed the important series of facts;—that the liver, having been wounded, had adhered in its middle lobe to the inner surface of the peritoneum;

the jejunum having been wounded just below the stomach by an incision half an inch in length, across the gut, this portion of intestine lying deep was not pressed against the inner surface of the abdomen, but remained in close contact with an adjoining turn of the jejunum—the two turns of intestine had adhered together, one showing the scar of the wound, the other béing untouched; the right side of the colon, wounded by an incision an inch long, had united and adhered to the inner surface of the peritoneum by about a score of long thread-like tags of false membrane, issuing from the inner surface of one of the largest scars in the abdomen. But these favourable results, however encouraging in apparently desperate cases of penetrating abdominal wounds, are yet exceptional. In by far the greater majority of such cases, the patients die, and especially when the small intestine is wounded; owing to the more frequent extravasation of feculent matter into the peritoneal cavity. Thus, during the American War of the Rebellion, out of about 650 cases wherein the abdomen was the seat of penetrating wounds implicating the intestinal canal, fifty were recognized lesions of the small intestine, principally from gunshot injury; and of the latter, there were only five cases of recovery. But out of eighty-nine cases as clearly wounds of the large intestine, in a considerable proportion relating to the cæcum and ascending colon, or to the descending colon and sigmoid flexure, in particular, the patients survived; with regard to the transverse colon, the recoveries were few. Wounds of the jejunum and the ileum are more often multiple, passing through the folds of these intestines, and consequently are most dangerous.

TREATMENT.—*Rupture* of any abdominal viscus—without wound of the abdominal wall—suggests only two indications of treatment: the restoration from collapse; and the restriction of extravasation, whether of blood or feculent matter, in order to prevent the supervention of Peritonitis. The one indication may be fulfilled by a judicious administration of stimulants, with other measures to induce reaction; the other may perhaps be accomplished by rest and sedatives. Opium in grain doses, or the liquor opii sedativus, should be given every four hours, so as to keep the patient under its influence; hydrocyanic acid and potash, to allay sickness; while the diet must be restricted to spoonfuls of cold beef-tea, with barley-water and ice, and no aperient medicine given for some days. A mild enema of gruel and castor oil will then be advisable.

Penetrating wound of the Abdomen, not involving any viscus, should be closed in the ordinary manner of a wound in a loose and movable part. A few points of suture must be introduced to steady the edges of the integument in apposition, aided by a suitable position to relax the abdominal muscles; but the precaution of a compress and bandage will be requisite as a support, to prevent the risk of visceral protrusion. It is this liability which has led to the more recent use of quilled sutures, or of twisted sutures, for the deeper coaptation of the divided muscles. In gunshot wound, the presence of a foreign body, as a ball, portion of clothing, or piece of bone, may allow of a superficial examination with the finger or probe, in order to remove it from the wound; but no deep exploration should ever be made, with the view of extracting any foreign body from the cavity of the abdomen or pelvis. *Intra*-abdominal hæmorrhage is another complication which may attend a penetrating wound, or follow as secondary hæmorrhage. Some viscus is involved, the blood proceeding from a branch of the epiploic, the mesenteric, the gastric, or other arteries; or from the substance of the viscera. When the source of hæmorrhage can be discovered, as a distinct jetting stream of blood upon the finger introduced within the cavity of the abdomen, it will be justifiable to proceed to control the bleeding by torsion or ligature; enlarging the wound, if necessary, for this purpose. Successful cases of this kind are not unknown. But generally the Surgeon must be content with having recourse to the ordinary hæmostatics; rest, astringents, and the efficacy of opium, with the topical influence of cold, by means of an ice-bag. Venesection, although still practised by French and German Surgeons of large experience, and with whom I concur, is denounced by men of equal authority in America,—as testified by their practice in the War of the Rebellion. With regard to intrathoracic hæmorrhage, their judgment respecting blood-letting is no less adverse.

Protrusion of any viscus, commonly a portion of intestine or omentum, must be met by early reduction, before signs of strangulation have supervened. Relaxation of the abdominal muscles, by position and gentle manipulative pressure, is the rule to be observed. A pedunculated constriction of the protruded mass may be overcome by slightly enlarging the aperture with a probe-pointed bistoury or hernia-knife. If adhesions have taken place, they may be detached, when recent and slight; but when firm and extensive, they had better be left alone, rather than endanger the bowel by any forcible separation or cutting division; and the Surgeon must be content with relieving the constriction,—thus conforming to the usual rule, with regard to this complication, in the operation for strangulated hernia. In returning the part, the direction of pressure should be towards the abdominal cavity through the aperture; lest, otherwise, the protrusion be slipped between the muscles, leaving the neck unreduced. Having entirely returned the part into the abdomen, the finger should not follow it further; the gut or omentum may remain more safely placed near the aperture, that in the event of sloughing there shall be a free vent for the discharge. An inflamed state of the protrusion does not contra-indicate its reduction; but gangrene of the intestine must be treated on a different principle,—an incision to discharge the contents of the protruded portion, and the formation of an artificial anus. Gangrenous omentum should be removed by excision, the arteries having been each separately ligatured; and the stump of the mass removed should be left just within the wound, as under similar circumstances in the operation for strangulated hernia, and for the same reasons.

Wound of the intestine modifies the treatment, according as to whether the bowel be protruded or not. Wound of the intestine *without protrusion* is out of reach; and the discharge of fæcal matter must be facilitated. The patient should be laid in such a position that the contents of the intestine shall escape through the external wound in the abdominal wall; lying on the injured side may offer the most dependent position to the opening, or the recumbent attitude, with the knees drawn up, may best facilitate the discharge from a wound near the umbilicus. Considering the risk of feculent extravasation, and the consequent peril, this mode of treatment, by position, is open to question. Large experience would seem to show that when the intestine is penetrated, without protrusion, the general rule should be to close the intestinal wound by suture—*i.e.* practise enteroraphy; having enlarged the abdominal opening, if necessary, by an exploratory incision, to find the seat of intestinal lesion. Recourse to enteroraphy, under these circumstances, was more or less expressly sanctioned by Legouest in the Crimean War, by Lohmeyer in the Danish War, and by Beck in the Franco-German campaign; and exploration with enterography is strongly advocated by Dr. Otis, from the results of numerous cases adduced in his comprehensive "Surgical History of the American War" (1861–65). But I think that objections to this mode of treatment should not be overlooked; for, as the intestine remains within the abdomen, in searching to find the wounded part, fæcal extravasation is very apt to occur; and more especially if perchance several folds of the bowel be penetrated. Wound of the intestine, *with protrusion*, is a condition respecting the treatment of which surgical authorities have also held a difference of opinion. Closure of the wound with sutures—enteroraphy—and reduction of the protruded portion of intestine just into the cavity of the abdomen, constitutes the plan of treatment generally applicable. The sutures, according to Travers's observations on animals, soon become coated over with a layer of lymph, and ulceration taking place inwards, they are eventually detached and fall into the intestinal canal; while the line of incision uniting by adhesion, leaves a firm cicatrix. For this purpose, it is necessary to bring the peritoneal margins into contact, as the source of adhesion. The needle used should be a fine round needle, and the sutures, fine round sewing-silk; the whole thickness of the gut should be brought together, into even apposition, and the sutures clipped off close to the knot. To avert any tendency to the escape of fæcal matter in the intervals of this interrupted suture, the continued or glover's suture will be preferable for a wound of any extent; observing to pass the thread from within outwards, and from without inwards, alternately; thus to invert the lips of the intestine, and bring the peritoneum into contact. When returned into the abdomen, the gut is left near the external aperture, to allow of free discharge in the event of sloughing. The abdominal wound, if extensive, may be partially closed by suture; leaving a dependent opening.

Another plan of treatment, which has been recommended by some Surgeons of experience, consists in reduction of the protruded portion, just into the abdomen, without closure of the wound in the gut, and so that the two apertures, intestinal and parietal, shall correspond and lie in contact. Adhesion taking place between the two apertures, an artificial anus is formed. The alleged advantages of this procedure are: the absence of sutures, as foreign bodies, and the prevention of feculent extravasation incident to the mechanical closure of an intestinal wound by sutures. The mechanical efficacy of sutures is, however, now no longer a question. And the obvious disadvantages of attempting to form an artificial anus are: the liability of feculent extravasation pending adhesion of the two apertures, subject also to alteration of their relative position; and the sad inconvenience of a permanent artificial anus in any part of the abdominal parietes. But an extensive and transverse wound, or a lacerated wound of the intestine, cannot be closed effectually by suture; it will almost inevitably reopen by sloughing; and a wound of intestine already gangrenous is unfit for reduction. In these *exceptional* conditions, the formation of an artificial anus will be expedient or unavoidable.

The *after-treatment* of wounded intestine, with or without protrusion, is the same as that of rupture. The principle being to prevent any peristaltic action which might disturb the process of reparative adhesion, opium should be administered to confine the bowels for a week, when a castor-oil enema may be given. During this period the diet should be sparing and exclusively fluid; subsequently, a small quantity only of light solid food may be gradually allowed for two or three weeks.

Protrusions of other abdominal organs have been dealt with by excision or ligature. Portions of the spleen, or of the pancreas, have thus been removed, and successfully.

TRAUMATIC PERITONITIS.—Inflammation of the peritoneum, consequent on injury, whether contusion or wound of the abdomen, or arising from extravasation—feculent or alimentary, bilious, urinary, or sanguineous—is denoted by certain characteristic symptoms. Pain and great tenderness on the slightest pressure, spread from the seat of injury over the abdomen, accompanied with tympanitic distension and resonance on light percussion. A dry tongue, which soon becomes brown, constant nausea or vomiting, and obstinate constipation, are the main gastro-intestinal symptoms. The patient lies recumbent, with his knees drawn up to relax the abdominal muscles, as the easiest position; he breathes entirely by the thorax, the abdomen scarcely moving with each respiration; and the expression of countenance is anxious, with perhaps a nipped appearance of the nose,—owing apparently to dilatation of the nostrils and a bleating action of the alar cartilages, in connection with the short and hurried breathing. A distressing hiccup often adds further embarrassment; so that the patient speaks with a panting and broken voice. The pulse is rapid, small, and hard, often feeling like a wire drawn under the finger; increasing rapidly to 100, 120, or more beats per minute, it becomes proportionately weak and irregular as vital power declines. Effusion takes place into the cavity of the peritoneum, and resonance is then exchanged for dulness on percussion; commencing in the flanks, where the fluid portion first accumulates, and gradually extending over the abdomen, as it increases in quantity. The lymph effused, commonly of greenish-yellow colour, may be fibrinous and plastic in character, fitted for adhesive reparation; or corpuscular and curdy, with an abundance of yellow serum, or sero-purulent fluid. The peritoneal surface is more or less injected, both in its visceral and parietal aspects; the tint of redness and form of vascularity varying in different parts of the membrane. Peritonitis after abdominal injury begins usually in about twenty-four hours, or from that to three days subsequently; as *acute* inflammation, it may run its course rapidly, in either of these periods or longer, and sometimes it assumes a *chronic* form. Plastic or reparative peritonitis is of a *sthenic* character; corpuscular, and especially purulent, peritonitis is of an *asthenic* character, and speedily fatal.

Treatment.—These two general characters of Peritoneal inflammation indicate the plan of treatment. In both forms of the disease, the measures to be adopted consist in topical blood-letting by means of leeches scattered over the surface of the abdomen, and warm fomentations; coupled with the administration of calomel and opium, in pill, every four or six hours, in order to prevent effusion beyond that requisite for adhesive reparation, and to promote absorption. Neither local depletion nor warm epithems proved efficacious in the numerous cases of traumatic peritonitis during the American War of the Rebellion; but the continued influence of ice over the entire abdomen was often used to subdue the peritoneal inflammation. The action of mercury in relation to inflammatory effusion may be open to question; but in traumatic peritonitis, the early administration of opium is specially advantageous, by controlling the peristaltic movement of the intestines. The hypodermic injection of morphia is a valuable resource when opium would be rejected by the stomach; but opiate suppositories have a more direct effect upon the intestine. Purgatives during the inflammatory stage are useless or injurious, the constipation depending on the paralyzing influence of peritoneal inflammation over the peristaltic action of the bowels. In the case of wound of the bowel, this state of quiescence is necessary for reparation, and Nature's provision for that purpose. Beef-tea and other fluid food should be the only form of nourishment given during this period. Iced soda-water or barley-water seems to allay sickness, which may also be combated by hydrocyanic acid and potash, in draught, taken occasionally. At the end of about a week any feculent accumulation may be removed as a source of irritation, by the gentle action of an oleaginous enema. In *asthenic* peritonitis, depletion should be moderated, and the vital power must be soon sustained by wine, brandy and egg mixture, or other stimulants, and light nourishing food.

Chronic peritonitis will require the continued influence of mercury, with blistering of the abdomen and mercurial ointment dressing, to remove the lingering effusion. Compression, by means of an abdominal support, may also promote absorption; although I have had no experience of the gypsum-bandage, which Neudoerfer recommends, and, I believe, employs in the acute stage, for the suppression of inflammation.

CHAPTER LVI.

HERNIA.

HERNIA is a generic term, signifying the protrusion of any organ from its natural cavity; such protrusion occurring through a natural or accidental aperture. Thus we recognize Hernia of the brain, through an opening in the skull; of the lung, through an opening in the thoracic parietes; of a portion of intestine, omentum, or other abdominal organ, through an opening in the abdominal wall. The protruded part is covered by the integuments, which overlie the aperture and course of the protrusion; and this structural condition may be said to distinguish Hernia from Prolapsus, which is simply an uncovered and exposed protrusion of any organ, as of the uterus or rectum. Hernia and Rupture are frequently used as synonymous terms; but the latter term would imply some breaking or laceration of the textures resisting at the seat of visceral protrusion, a lesion not necessarily connected with the production of Hernia.

ABDOMINAL HERNIA may be considered, in its General Pathology and Treatment; and that of the various Special Forms of such Herniæ.

SITUATIONS OF HERNIA.—The various apertures naturally existing in the abdominal parietes offer structural facilities for the protrusion of the viscera; while apertures accidentally existing as malformations, or formed by injury or disease, also favour the occurrence of Hernia.

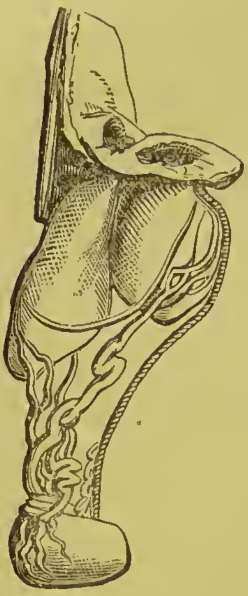
Taking the former as the more common and normal, or anatomical situations of Hernia, they are; above Poupart's ligament—through the inguinal canal; below the ligament—through the femoral canal; through the several apertures of the pelvis;—in front, through the obturator or thyroid foramen; through the arch of the pubes in the perinæum; below,—into the labium pudendi, by the side of the vagina; behind,—through the ischiatic notch; through the umbilical aperture; or at other parts of the abdominal wall, in ventral, epigastric, and lumbar Herniæ; and through the diaphragm.

NAMES OF HERNIÆ.—Distinctive names are given to abdominal Herniæ, according to their anatomical situation; the viscus protruded; the period of life at which the hernial sac is formed; the stage of protrusion; and the pathological condition of the herniæ. Thus we recognize by their *situation;* Inguinal hernia, Femoral or Crural hernia, Obturator or Thyroid hernia, Perineal hernia, Pudendal hernia, Vaginal hernia, Ischiatic hernia, Umbilical hernia, Ventral hernia—at the linea alba, or the linea semi-lunaris, Epigastric hernia, Lumbar hernia, Diaphragmatic hernia. The *protruded viscus* gives names; Intestinal hernia or enterocele, Omental hernia or epiplocele, their combination being Entero-epiplocele; hernia of the stomach or Gastrocele; of the bladder or Cystocele. *Congenital* hernia, and its variety, *Infantile* or *Encysted* hernia, relate to the formation of the hernial sac by the persistent patency, from birth, of the vaginal process or sheath of peritoneum in the tunica vaginalis testis; the one condition signifying complete patency of this sheath; the other, its closure at the abdominal orifice, leaving the sheath open below, and into which the hernial sac descending, the tunica vaginalis encloses the sac—forming an encysted hernia. *Complete* and *Incomplete* hernia are terms having reference to the stage of protrusion; inguinal hernia incomplete, or within the canal, is named bubonocele, and when complete, scrotal hernia in the male, labial in the female. The pathological condition of hernia gives rise to highly important practical distinctions; *reducible* hernia, *irreducible* hernia, *incarcerated* and *strangulated* herniæ.

GENERAL STRUCTURE OF ABDOMINAL HERNIA.—The Hernia consists of a peritoneal sac or pouch, with a corresponding portion of the abdominal parietes, and the sac-contents.

Sac.—The *sac* is a prolongation of the parietal layer of peritoneum, from the aperture in the abdominal parietes; but this prolongation is of two distinct kinds in its relation to a Hernial protrusion. The sac may be produced in two different ways; either by gradual protrusion and distension of the peritoneum under pressure of the protruding organ,—forming the ordinary, *acquired* hernial sac; or it may be a pre-existing vaginal process of peritoneum, left open after birth as a malformation, into which sheath an organ protruding, it thus becomes a hernial sac,—the *congenital* hernial sac. Both kinds of sacs are illustrated by inguinal herniæ.

FIG. 772.*



A hernial *sac* consists of two portions: the *body*, or dilated portion, the lowest part of which is sometimes named the fundus; and the *neck*, or constricted portion, the abdominal opening into which is named the mouth of the sac. These distinctive terms are convenient for description, and practically important. *Varieties.*—The sac may be *absent* in certain structural conditions of hernia;—if the protruding organ be naturally partially uncovered by peritoneum, as the cæcum or bladder; in hernia within the abdominal cavity, as by protrusion through the mesentery or the meso-colon, or by the formation of an adventitious band of false membrane constricting a portion of intestine; from rupture of the sac by violence; or as the result of ulceration. On the other hand, *two* sacs may have formed, both having protruded through the same aperture, constituting a double hernia. One sac may be placed behind (Fig. 772), or within the other.† Occasionally, the sac may be bifurcated.‡ The *neck* of the sac somtimes consists of *two* constricted portions; representing the natural anatomical condition of the surrounding parts,—as the external and internal abdominal rings, in complete, oblique inguinal hernia; or, the original neck may have slipped down with a fresh protrusion, forming the "sacs aux collets" of French authors. I have thus seen *three* necks produced, or corresponding constrictions, in a large scrotal omental hernia. These thickened rings vary in position with relation to the axis of the sac, as Cloquet observed; being transverse or oblique, according to the more or less equal descent of the sac. The rings consist of fibrous indentations of the peritoneum; and sometimes they pass inwards as duplicatures, forming septa or partitions, dividing the sac into two cavities, which communicate by a central aperture. Occasionally, an incomplete ring has a corresponding semilunar valvular fold, within the sac; or forming an almost complete septal division. (Fig. 773.)

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* Roy. Coll. Surg. Mus., 1335. Double inguinal hernia—oblique, on the right side, showing two sacs, an anterior and a posterior. The former has a smaller mouth, is elongated, and is four inches in length. The posterior is larger, and nearly globular, and has a wider mouth, being an inch and a quarter in its transverse diameter. The spermatic vessels (veins varicose) and vas deferens are attached to the back of this sac and the lower part of the anterior sac; and the epigastric artery makes a wide circuit, passing round and to the inner side of the necks of both sacs. The patient was sixty-eight years old, and there had been symptoms of strangulation for three days; a small hernia had been returned on the *left* side, and one could be made to descend on the right side by coughing, but could be very easily returned. The symptoms of strangulation becoming urgent, operation was performed on the *left* side; and an empty sac was found in the inguinal canal. Death took place the next day; and then the smaller anterior sac, on the right side, was seen to have been pushed into the abdomen, together with a portion of intestine, strangulated by its neck. This had probably occurred in reducing the intestine from the larger posterior sac. See also Guy's Hosp. Reports, vol. iv. (Sir A. Cooper.)

† See Ibid., 1291. Femoral herniæ; a larger old sac, a recent sac above, in the usual situation of femoral hernia; and two or three small sacs near the sides of the old one. At the *back* of this specimen, and near the mouth of the recently protruded sac, on its outer side, directly over the femoral vessels, there is the appearance of another small peritoneal protrusion. A portion of the ileum, just the diameter of the bowel, was strangulated; the intestine above the strictured part is distended, that below being of its natural size. The patient, a woman, having symptoms of strangulated femoral hernia, an operation was performed, and on opening the lower sac, it was found empty; the upper recent sac, which contained the portion of strangulated bowel, was not opened, but the stricture at Poupart's ligament was divided, and the contents of the sac were readily returned. Death ensued in six hours. (J. Hunter.)

‡ See Ibid., 1288. A large inguinal hernial sac; at its lower part branching into two pouches of equal size, one lying behind the other. (Hunterian.)

Structural Changes in the Sac.—The size, shape, and textural condition of the peritoneal prolongation vary according to the period of its formation, in the *acquired* hernial sac. Commencing as a small digital depression, it assumes the shape of a funnel, and then that of a finger of a glove. These forms are, however, somewhat dependent on the region in which the hernia is developed. At this early period, the entrance to the sac is larger than the body,—there is no true neck, and strangulation of the protruded organ cannot occur. At length the sac, reaching tissues of less resistance, undergoes dilatation and acquires a spherical shape; while the entrance becoming proportionately constricted and puckered, forms a neck of variable length and calibre, so that strangulation can occur. In this state, the sac may retain the originally thin, transparent texture of peritoneal membrane; but it soon becomes adherent to adjoining parts. Organization takes place, in both the body and the neck of the sac, more particularly in the latter portion. The sub-serous cellular tissue is the principal seat of these textural changes. They consist in the formation of new blood-vessels, increasing the vascular appearance of the peritoneal surface, and a contractile induration of the cellular texture, attended with a marked diminution or disappearance of the fat, although the person be very fat. This textural transformation of the peritoneum is evinced by thickening and opacity of the sac, especially its neck. Contraction follows to some extent, and even obliteration, when the hernial protrusion ceases. The peritoneal transformation acquires a fibrous and less vascular character, and the consequent induration may be cartilaginous, or even ossific, in the form of plates. This is the state of an *old* hernial sac (Fig. 774), and the contraction is most notable when

FIG. 773.*

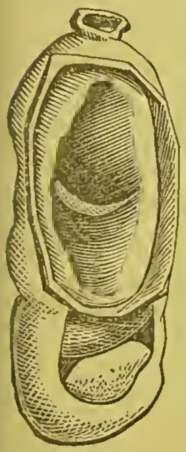
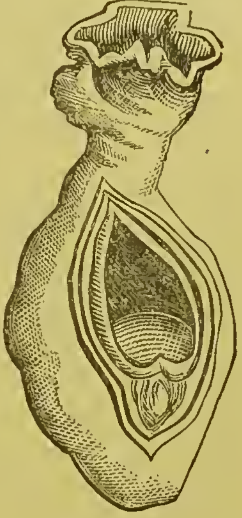


FIG. 774.†



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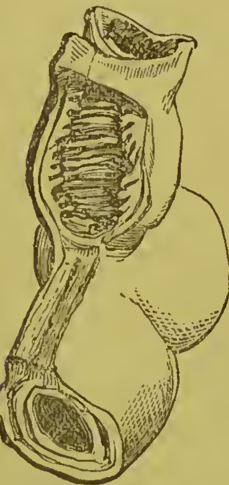
[*] Roy. Coll. Surg. Mus., 1287. A large inguinal hernial sac; showing also a double cavity, formed by a transverse crescentic fold or partition from its posterior wall. (Sir A. Cooper.)

[†] Ibid., 1289. Thickened sac of old inguinal hernia. (Liston.)

the sac has not been subject to hernial protrusion for some time. As affecting the neck, such change is at once perilous and curative; the one, by inducing strangulation, in the event of a hernial descent of any organ; the other, by leading to obliteration of the neck of the sac. During all these changes in the structural condition of the sac, the visceral layer of peritoneum, which invests the protrusion, retains its thin and transparent texture, with its polished, serous secreting surface,—in contact with that of the interior of the sac, whenever the hernial protrusion descends.

Abdominal Parietes—and their Structural Changes.—The layers of different textures, constituting the abdominal parietes, through which a Hernial protrusion successively passes, form what are termed the *coverings* or investments of Hernia, in addition to the peritoneal sac. The aperture or apertures in the parietes, through which the protrusion begins, corresponds to the neck of the sac. Both the aperture and the coverings undergo remarkable changes, which may almost or altogether efface the original anatomical characters of these parts. The changes here referred to are partly mechanical, and partly textural. The hernial aperture becomes altered in shape, assuming a circular form, and enlarged, while its relative position is gradually displaced, and usually towards the middle line; two apertures thus forming one, as that of the abdominal rings in oblique inguinal hernia. The coverings of hernia gradually become stretched and loose, so that the skin appears redundant and wrinkled, when an old hernia is reduced. Textural changes consist in thickening and induration of the parietal aperture; and in the obliteration of the individual characters of the coverings, which are more or less fused into one, and with which the sac is consolidated. (See Fig. 774.) All these changes result from detrusion and pressure by the hernial protrusion, operating mechanically on the parts, or inducing textural degeneration and atrophy; or textural transformation may be the result of inflammatory adhesion,—consequent on the constant pressure of a truss-pad, a blow, or excessive manipulation. The general atrophy which the coverings of hernia undergo is not shared by all alike; for often the subperitoneal cellular tissue becomes loaded with granular fat, looking like omentum, but enclosing the sac. Sometimes cysts form around the sac; either as the result of obliterated abortive hernial sacs, according to Cloquet's description, or as an independent cystic development in the subperitoneal cellular tissue. Thus, then, the whole Pathology of Hernia must be regarded as a more important aspect of study than its pure Anatomy.

Fig. 775.*



Contents of the Sac—and their Structural Changes.—All the abdominal viscera are severally subject to Hernia, though not with equal frequency; the pancreas, it is said, alone excepted. The contents of a Hernial sac, therefore, vary considerably. They are usually the intestine or omentum conjointly or singly; the small intestine, particularly the ileum, more probably than any other abdominal viscus, owing to its long mesenteric attachment and its hanging near the abdominal apertures through which herniæ commonly take place—namely, the inguinal and femoral rings. The quantity of intestine protruded may be small,—a knuckle of intestine (Fig. 775), or not even the whole of its circumference (Fig. 776), or it may extend to several feet in length. Omentum, varying in quantity, is folded together, or perhaps matted into a cylindrical mass; when unfolded, it has a triangular or fan shape, the base being below and the apex upwards at the abdominal aperture. Old herniated omentum loses its peculiar ramified adipose cellular texture, and becomes consolidated; the veins assuming a somewhat varicose condition. Sometimes apertures form in it, through which a coil of intestine passing, strangulation may happen within the sac. Cysts, occasionally, form in the omentum, and into which the intestine may slip. When intestine and omentum coexist in the sac, usually the omentum descends in front, and will be found to enclose and conceal the intestine, on opening the sac. This is explained by the situation of the great omentum, which hangs as an apron from the greater curvature of the stomach, immediately behind the abdominal wall; and thus also omentum is more often protruded in umbilical and inguinal than in crural herniæ. Occasionally, other viscera are herniated; the stomach, liver, spleen, cæcum, sigmoid flexure, or other portion of the colon, bladder, uterus, ovaries, or even the kidney. Serous fluid, of a yellowish or brownish colour, and transparent, is always found within a hernial sac, but in very variable quantity. Usually only sufficient to lubricate the interior and contents of the sac, this fluid may be the principal constituent, amounting to several ounces, and distending the sac. It is copiously secreted when the sac is inflamed or the hernia strangulated, and most abundantly in inguinal herniæ.

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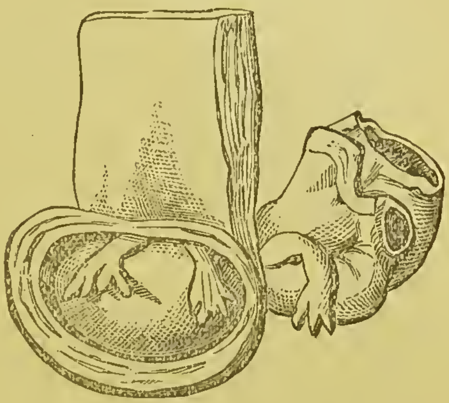
* Roy. Coll. Surg. Mus., 1297. Portion of jejunum, which was strangulated in an umbilical hernia. (John Howship.)

FIG. 776.*



Adventitious or false membranes, forming *adhesions*, are met with; either as the product of inflammation in strangulated hernia, or as the result of changes in old irreducible hernia. The situation, length, thickness, and density of these adhesions present many differences of appearance. Thus, adhesions may have formed between the interior of the sac and its contents, in the shape of uniting bands, or as bridles across the sac from one side to the other, imprisoning the contained viscera; or again, adhesions may have taken place between the latter, as between two coils of intestine, or between intestine and omentum.

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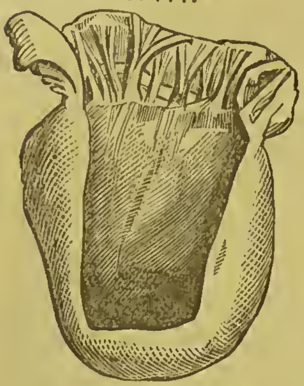
* Roy. Coll. Surg. Mus., 1302. An unreduced strangulated femoral hernia; in part only of the circumference of the bowel; showing also contraction of the intestine before the strictured part, and dilatation of the part behind it. The patient, a woman aged thirty-five, had a rupture for several years; this was reduced from time to time, until on one occasion symptoms of strangulation set in, and continued after reduction had been accomplished; straining and vomiting reproduced the hernia, which now could not be returned. An operation was proposed by the Surgeon, Mr. Thomson, and refused. (Hunterian.)

The neck of the sac is frequently the principal seat of adhesions. (Fig. 777.) Parietal and visceral adhesions not unfrequently coexist. Rarely, a complete false membrane may have formed, attached to the interior of the sac or loose in the cavity. *Recent* adhesions are soft and pliant; *old-standing* adhesions are firm and unyielding. They are sometimes discoloured, as if blood-stained.

FIG. 777.*



Adhesion of the omentum across the sac, so as to form a distinct sac or cyst below the visceral contents, and in which fluid accumulates, constitutes the condition known as *hydrocele of the hernial sac.* A considerable quantity of fluid may thus accumulate; some ounces or even pints. It is a rare structural alteration in the hernial sac; one only having been noticed by Curling, one by Boyer, one by Lawrence, two by Pott, and two by Pelletan. Sometimes, a duplicature of the peritoneum, corresponding to a constricted ring externally, forms a complete septum within the sac; thus leaving a closed cyst, as Cloquet describes it, below the hernial protrusion. To these I can add one, formed in another way; by closure of the neck of the sac, after reduction of a strangulated scrotal hernia by operation. The compress applied to secure reduction, speedily induced adhesion of the neck of the sac, and fluid accumulated below in the body of the sac; soon presenting the original appearance as if the hernia had returned. I tapped this scrotal sac, and drew off several ounces of brownish fluid which was not re-secreted. The fluid of *ascites* is apt to pass into and distend a hernial sac, as if a hydrocele of the sac. But this state is distinguished by the ready return of the fluid into the abdomen on compressing the swelling, and its escape again when the hand is withdrawn.

Black spots, or brown and red patches, sometimes beset the peritoneal surface of the sac, and of the visceral protrusion; or these marks may be so diffused as to give a tawny hue to the whole peritoneal surfaces. These appearances are probably the result of ecchymoses, the blood having undergone various changes of colour. This condition might perhaps be mistaken for gangrene.

Loose foreign bodies are occasionally found within the hernial sac; they are usually round, smooth, and firm, varying in size from a pea to a chestnut, and single. They consist of a laminated fibrous envelope, with a central fatty nucleus; apparently one of the glandulæ epiploicæ detached, and encapsuled. Other bodies may be met with of a cartilaginous nature, and which are produced by the detachment of the plates which sometimes form in the walls of an old hernial sac.

Strangulation.—The structural changes coincident with the *strangulation* of hernia demand special notice. The visceral protrusion is nipped and indented at the seat of strangulation—the *stricture.* Other changes relate to *adhesions*, the state of the *intestine*, or *omentum*, and of the *serous fluid* in point of its colour, consistence, and odour. *Adhesions* have already been described sufficiently; their situations, and their characters as *recent* adhesions, compared with the old-standing adhesions of irreducible hernia. Within a very short period plastic lymph may have been effused, and even become vascular in twenty-four hours; appearing as shaggy villi, or bridles, and sometimes having a cellular or a membranous form. The following changes take place concurrently in the state of the serous fluid and intestine within the sac, and are notably important; the one as being an indication of the other. With strangulation of only a *few hours'* duration, the fluid is pale yellow, clear, and bright; the intestine is simply *congested*, of a deep-red colour, and its texture elastic. With strangulation of *many hours'* existence, the fluid is dark brown, but clear, and the intestine of a purple tint, but its texture still retains its elasticity. With strangulation of *long duration*, or after violent and protracted taxis, the fluid resembles a strong infusion of coffee, it is turbid, with blood and small coagula mingled; the intestine is dark purple shading to black, it has lost its peritoneal brilliancy and become dull looking, its texture is leathery, not resilient, infiltrated with blood, and often having flakes of lymph adherent to its surface. With turbid serum, of a dull brownish-yellow colour, mixed with blood, coagula, flakes of lymph, or rarely pus, and probably having a feculent odour, the intestine—having a blackish colour, dull appearance, and fleshy, softened consistence—is approaching to a *gangrenous* condition; or it has already passed into *sphacelus*, when shreds of the peritoneal coat readily peel off. (Fig. 778.) With the escape of gas through serum, of the nature last described, bubbles are produced, and the intestine is *ruptured*. (Fig. 779.)

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* Roy. Coll. Surg. Mus., 1309. The sac of an inguinal hernia; showing firm *adhesion* of omentum to the neck, in the form of thick strong bands of false membrane. (Hunterian.)

FIG. 778.*

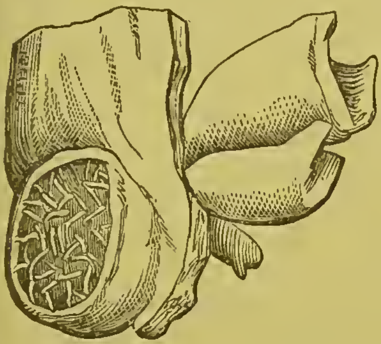
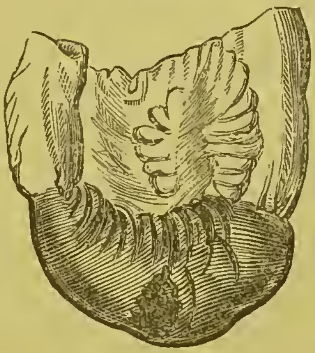


FIG. 779.†



In the natural course of unrelieved sphacelated hernia, the *sac* and *integumental* coverings become inflamed, infiltrated with serum and pus; crepitation ensues, either by the escape of gas from the sac or its formation in the decomposing textures externally, and gangrene of the skin supervening, the slough separates, and an artificial anus is established. At the same time, firm adhesion takes place between the neck of the sac and the hernial aperture; thus preventing the escape of fæcal matter backwards into the abdomen. If the hernial stricture were relieved at this or even an early stage of gangrenous intestine, and short of sphacelus, the intestine might not regain its vitality; the portion of bowel remaining nipped and marked as by a band constricting it. I have thus seen strangulation of only half the circumference of a portion of intestine prove fatal after operation.

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* Roy. Coll. Surg. Mus., 1299. Portion of jejunum *sphacelated*; the strangulation having been so tight that minute injection could not pass into its vessels, from the portion of bowel within the abdomen. Adhesion of the strangulated part to the interior of the sac had taken place. (Howship.)

† Ibid., 1305. Portion of gangrenous small intestine; showing a *rent*, extending half round the circumference of the bowel. The margins of the opening are not ulcerated. The mark of constriction on the bowel remains, after strangulation; and probably an unsuccessful attempt to reduce, producing rupture. (Sir W. Blizard.)

Omentum passes through similar changes of congestion and gangrene; and, if unreduced, the sac and its coverings may slough, and the portion of omentum become detached, the patient making a good recovery.

Peritonitis coincident with strangulation, commences about the neck of the sac, and spreads over the abdomen. The pathological appearances are not peculiar; an injected peritoneal surface, with plastic lymph of greenish-yellow colour, agglutinating the intestines or overspreading them, and puriform serum accumulated in the cavity of the peritoneum. From 126 fatal cases of hernia, collected by Mr. Bryant, it would appear that in about 69 per cent. peritonitis with lymph-effusion is the cause of death.

CAUSES.—The formation of Hernia depends upon a weakness of some point of the abdominal or pelvic wall, and thus an insufficient resistance to the protruding pressure of the viscera, as subject to the compressing action of the abdominal muscles and diaphragm. The causes of hernia are, therefore, of two kinds, predisposing and exciting.

(1.) *Predisposing* causes.—*Structural* predisposition consists in the natural existence of the various anatomical apertures in the abdominal and pelvic *wall*, corresponding to the normal situations of Hernia; and congenital malformation is predisposing, chiefly as connected with congenital and infantile inguinal hernia; or the predisposition may arise quite accidentally, from injury—by contusion, or by distension of the abdomen during pregnancy or dropsy, or as the result of disease—by abscess or other weakening disorganization of some part of the abdominal wall. *Laxity* of some of the abdominal *viscera* might be reckoned among structurally predisposing conditions—*e.g.*, the ileum having a long mesenteric attachment, and hanging near the inguinal and femoral rings; the omentum also loosely hanging as a sort of abdominal apron, when not tucked up to the right as in some cases.

General predisposition relates to sex, age, hereditary influence, and occupation.

Sex.—*Males* are far more subject to hernia than females. Mr. Kingdon estimates the proportion at 2 males to 1 female, for all ages and including every form of hernia. Out of a gross total of 96,886 applicants for trusses at the City of London Truss Society, 78,394 were males; 18,492 females. In relation to the *population*, the frequency of hernia is uncertain; the proportion has been estimated as high as 1 in 8 of the male inhabitants of the whole kingdom, and 1 in 5 of the inhabitants of one district. In France, Malgaigne estimated the proportion as being 1 man in 13, and 1 woman in 52. In relation to the *situation* of hernia, males are more subject to inguinal, females to femoral and umbilical herniæ. The relative proportion is shown by various numerical records. Thus, from a collection of cases by Mr. Bryant, we find that in 52 of inguinal hernia, all were males; but of 65 femoral, 13 only were males, and the remaining much larger proportion, 52, were females. Of 8 umbilical herniæ, however, 6 occurred in males.

Age.—Differences of opinion prevail respecting the liability connected with the period of life. According to Malgaigne, hernia is less frequent before the age of 35 years than after that period; Birkett affirms that, taking all varieties of hernia in both sexes, the majority are developed before 35 years of age. By reference to statistics, out of 2343 cases recorded by Malgaigne ("L'Union Médicale," 1854), 555, or 23·6 per cent., were under 35 years of age, and 1788, or 76·4 per cent., above that age. On the contrary, out of 9296 cases recorded by Mr. Kingdon, 5659, or 60·8 per cent., had commenced before the age of 35 years, and 3637, or 39·2 per cent., after that age. The great discrepancy between these results is easily explained; the one series records the ages of the patients at the time of observation, the other had reference to the ages when the hernia was first noticed—the essential element in estimating the relation of period of life to hernial protrusion.

Age in relation to the *situation* of Hernia.—It appears from Mr. Bryant's collection of cases, 126, that with regard to inguinal hernia, twenty to forty years of age is the period when the rupture most frequently commences; that in femoral hernia these ages are comparatively rare, and that generally it begins between fifty and seventy years of age.

Age in relation to *Sex.*—The proportion between males and females, subject to Hernia, varies considerably at different periods of life, owing to congenital predisposition. According to Mr. Kingdon's statistics for 1860–61, in the first five years of life, the proportion was 1409 males, and only 107 females; while in the five years from twenty-five to thirty years of age, the ratio had changed to 846 males against 207 females.

Hereditary influence.—The children of ruptured parents are frequently affected in like manner. Both sexes evince an equal tendency to be thus influenced, in about the proportion of thirty-four per cent. This influence, paternal, maternal, or from both parents, is manifested mostly in infants under one year; the proportion being about twelve per cent. of the whole number under that age. This fact is referable, apparently, to an arrested closure of the vaginal process of peritoneum, or of its ventral orifice,—in regard to inguinal Hernia; and also to an abnormal elongation of the mesentery; both of which, as congenital structural conditions, are probably much influenced by hereditary conformation.

Occupation.—All persons are liable to hernia; but the labouring class is most subject, seemingly, however, irrespective of any particular trade or occupation. Comparing the twenty-five largest classes of occupation, arranged in the order of their magnitude from the census of 1851, with the numbers of each class who applied to the Truss Society during three successive years, Mr. Kingdon finds that the number of such patients bears a direct proportion to the numerical magnitude of the classes to which they respectively belong, and not to the severity of the toil.

(2.) *Exciting Causes.*—Any sudden and forcible diminution in the capacity of the abdominal cavity, resulting from the compressing contraction of the abdominal muscles, may be productive of hernia. Hence, it often happens in strained attitudes and postures of the body during the effort of any violent muscular exertion; and, in particular, hard riding on horseback, violent running or jumping, acrobat performances and ballet dancing, high pitch singing, violent coughing, straining defæcation or micturition in connection with constipation or stricture, and in difficult parturition. The production of hernia may be sudden, but perhaps more commonly it is of gradual formation.

Reducible Hernia.—*Symptoms.*—A colourless, soft, compressible swelling or lump appears at some part of the abdominal parietes; commonly in the groin, just above the middle of Poupart's ligament, at the internal abdominal ring; or below the ligament internally, and corresponding to the saphenous opening. This tumour increases in size when the patient stands, and still more so when he coughs, and the latter act communicates an impulse more or less perceptible to the hand when placed upon the tumour; on the contrary, it diminishes in the recumbent posture, and can be made to disappear by gentle compressive manipulation in the direction of protrusion,—the contents of the hernial sac, with sometimes the sac itself, being returned into the abdomen, whence this procedure is denominated the *reduction* of Hernia. The tumour will probably reappear, when the patient stands upright, and the pressure is removed from the hernial aperture. There is no pain or other sign of inflammation in connection with a reducible hernial tumour.

Intestinal hernia,—*enterocele*, and *omental* hernia,—*epiplocele*, present tumours having distinctive characters and which are tolerably perceptible. Enterocele is soft, compressible and elastic, uniform and globular; it yields a distinct and distending impulse on coughing, and a gurgling noise as it returns, suddenly, into the abdomen. Epiplocele is doughy or harder, inelastic, and uneven or lobulated; yields a less distinct and a solid impulse on coughing, and returns slowly, bit by bit, or as a lump, into the abdomen. Percussion cannot be trusted to distinguish intestine from omentum; for if there be fæcal accumulation—solid or fluid—in the bowel, the sound elicited from that structure, or from omentum, will be equally dull. *Entero-epiplocele* forms a tumour of mixed characters, and this is the more frequent condition of hernia; or examination fails to detect the visceral nature of the protrusion,—whether it be intestine, omentum, or both. An accumulation of fluid in the hernial sac will disguise the visceral nature of its contents, and simulate intestine. Thus, in one case of apparently scrotal enterocele, I found, by operation, only half the diameter of a knuckle of small intestine protruded at the external abdominal ring, and the sac distended with serous fluid.

Various kinds of swelling in the regions of Hernia simulate that disease; but their *diagnosis* will be more usefully noticed in describing Special Herniæ.

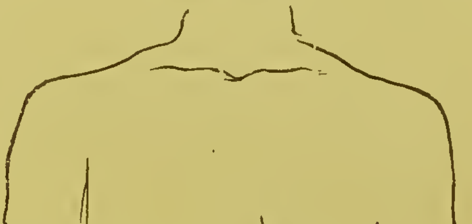
Treatment.—This may be mechanical and palliative, or operative and curative.

(1.) *Mechanical* treatment consists in the reduction or return of hernia, by the manipulative procedure technically named the *Taxis;* and the prevention of its return, by means of a suitably fitting support or Truss. The constant wearing of such an appliance may, perhaps, lead to obliteration of the neck of the sac, and a radical cure. Until a proper truss can be obtained, a pad or compress should be applied, and retained in position by a bandage; the spica-bandage being adapted for inguinal or femoral herniæ.

Taxis.—Reduction is effected by placing the patient in the recumbent position, relaxing the abdominal muscles by bending the thigh upon the abdomen, and then gently compressing the tumour with the fingers, back in the direction of protrusion. Sometimes, it has been recommended to empty the neck of the tumour downwards, by compressing this part between the finger and thumb, and then endeavouring to return the diminished neck through the ring. This method may be more practicable in an inguinal hernia than with the deeper neck of a femoral hernia. Inversion of the patient has sometimes been practised, in order that the force of gravity may aid the pressure of taxis, when that alone has failed. But no advantage has thus been gained.

Truss.—The qualities of a Truss should be estimated by its lightness, firmness, elasticity, and adaptation to the configuration of the wearer, with sufficient strength of spring to prevent the escape of the rupture from the abdomen. The instrument consists of a pad or cushion attached to a metallic spring, with straps so arranged that its movements during the varied postures of the body may be restrained. Bearing in mind these essential elements of truss-construction, a detailed description of the various forms of Trusses employed for the different situations of hernial protrusion will be far better understood in connection with Special Herniæ. The circular spring truss is, generally, the most suitable form. The names of trusses, more or less in common use, are these:—Salmon and Ody's self-adjusting truss, which has a pad revolving on a ball and socket; the Maidstone truss, with a sliding pad; Edward's truss, with a revolving and sliding pad; Adams's graduated pressure truss; Arnott's graduated pressure truss; Cole's truss, with a spiral spring acting on the pad; Tod's truss, affording more effectual compression at the internal abdominal ring; Newson's wire truss, affording more effectual security against displacement; Egg's truss, which requires no fastening; the Moc-Main lever truss; the Tail-padded truss; the Horseshoe-pad truss; and Bourjeaud's elastic india-rubber belt and pad, which may be more conveniently used for children.

Fig. 780.



The *measurements* necessary to insure a properly fitting truss are practically very important, and requisite for the Surgeon to know; especially when he has to communicate with the instrument maker at a distance, as in London from the country. Take the common forms of herniæ—inguinal and femoral. The whole circumference of the pelvis must be measured, lest any perchance natural difference on one side should alter the proportion of the truss. Place the end of the measuring tape over the lower hernial aperture, draw it in a slanting direction upwards to about two inches below the crest of the ilium, thence round the back to the same point on the opposite side, slanting down again to the aperture. (Fig. 780.) The size of the truss will be represented by the number of inches thus measured. The kind of pad—in respect to its shape, size, and attachment to the circumferential portion of the truss—must also be stated. Lastly, the kind and side of the hernia.

A truss having been applied, it should be *tested*, by desiring the patient to sit on the edge of a chair, with his legs wide apart, bending the body forwards, and then to cough. If, in that posture, and with such effort, the hernia still remains up, without any tendency to slip down behind the pad, the truss fits well, and will prove effectual under all ordinary circumstances. The truss should be worn daily, and taken off only at night. Irritation consequent on continued pressure of the pad, may be relieved by washing the skin with spirit lotion, and substituting an elastic air-cushion for a while. A piece of adherent omentum may undergo inflammation, suppuration, and gangrene from the pressure of a tight truss, leading even to peritonitis.

(2.) *Operations for Radical Cure.*—The principle implied by the cure of Hernia is the obliteration of the sac or its neck.

Compression of the whole neck of the sac, by means of a well-fitting truss, has led to its adhesive obliteration, in small and recent hernia, at an early period of life; the cure also being safe and remaining permanent. But this procedure must be continued for a considerable time, at least two years; and then, as a precautionary measure, prolonged for two years more.

The *changes* which the sac undergoes in the course of obliteration were carefully investigated by Cloquet. They consist of gradual contraction and atrophy, with adhesion of the inner surface of the peritoneal protrusion. Commencing, usually, in the neck of the sac, the peritoneum contracts into folds, radiating around the mouth of the sac, which here often becomes thickened; the whole having an opaque white, and wrinkled cicatricial appearance. Various modifications may be found, in the form of small cul-de-sacs between the folds, or small canals between the sac and abdomen. Further contraction, followed by adhesion, at length obliterates the neck of the sac; and the mouth may become adherent to the viscera which had been protruded, especially to an adjoining piece of omentum. The neck of the sac being reduced to a membranous or fibrous prolongation, the protruded portion is thus converted into a serous cyst—discontinuous with the cavity of the abdominal peritoneum. This cyst contracts upwards to the folds of the obliterated neck, at the abdominal aperture of the former hernia. When closely connected with surrounding parts, the cyst contracts in breadth into an elongated cord. In either case the walls become atrophied, thin, and transparent, although sometimes they are thick and opaque; the inner surface acquires a dull-looking, dry character, unlike peritoneum, and adhesion takes place, obliterating the shrivelled cyst, or leaving only a fibrous cord. If the sac was large, a transitional state may be found; adhesion having occurred in parts, a multilocular cavity is temporarily formed.

Various *operative* procedures have been devised for the radical cure of hernia, most of which having justly become obsolete may be here omitted. The object being to obliterate the sac or its neck, this may be accomplished, either by simple invagination of the sac and integument into the neck, the invaginated portion acting as a plug and closing the neck by adhesion between it and the hernial aperture; or, in addition to invagination, by the approximation and adhesion of the surrounding textures, thus producing further consolidation. Three operations are practised, in accordance with these two methods; Gerdy's and Wurtzer's operations are simply *invaginations;* Mr. John Wood's operation is, in addition, a *compression of the boundaries* of the hernial canal in its entire length.

The performance of these operations will be described in connection with the treatment of *inguinal* and femoral herniæ.

The results of any such occluding operation are uncertain; there is some risk of life, unwarrantable perhaps in order to remedy the purely mechanical inconvenience of a reducible hernia; and greater uncertainty as to a permanently successful result, without the inconvenience of continuing to wear a truss for protection against a relapse.

Irreducible Hernia.—This condition signifies simply that the contents of a hernial sac cannot be reduced or returned, entirely at least, into the abdomen; but there is no obstruction to the passage of fæces through the intestinal portion, nor to the circulation,—the hernia is not incarcerated nor strangulated. The contents are, generally, for the most part omental, with intestine and mesentery, and the hernia is usually long-standing and of large size; the gut perhaps slipping up occasionally, leaving the omentum unreduced. But nearly the whole of the abdominal viscera may be herniated. Thus, in scrotal hernia, examined after death, the sac has been found to contain all the intestines, except the duodenum and cæcum, with the omentum, the pyloric orifice of the stomach being drawn down to the pubes,—as was the case in the hernia of Gibbon, the historian; and even a portion of the stomach, itself enormously enlarged, was contained in the scrotum of a soldier, whose case Mr. Yvan communicated to the French Royal Academy of Medicine. The largest irreducible hernia I have ever seen was in the scrotum of a man in the Millbank Penitentiary—the scrotum, on the right side, hung down nearly to the knee; and Mr. Birkett met with a double scrotal hernia in a bricklayer, aged fifty-five years, where the tumour reached down very nearly to a level with the patellæ, and its circumference measured thirty inches. The left hernial tumour was the larger, although it had existed only about three years, whilst the right had been there twelve. Dr. Monro mentions a case in which the fundus of the hernia was four inches below the knee.

Causes.—Enlargement of the omentum or mesentery, as by an accumulation of fat, may lead to an irreducible condition of hernia; although the portion protruding through the mouth of the sac may be small. Adhesions between the sac and its contents, or adhesion of the neck of the sac, may severally produce the same result. Contraction of the neck is sometimes thus occasioned, or an hour-glass constriction of the sac; either of which alterations of shape will further prevent reduction. The great size of a hernia may render it permanently irreducible, in consequence of the visceral protrusion having formed for itself a new abdomen, and the proper abdominal cavity having undergone an altered capacity, while the viscera in either cavity have become accommodated to their new situation and relations. Hernia of the cæcum or of the bladder is irreducible, owing to their peculiar anatomical conditions.

Consequences.—The increasing size and weight of an irreducible hernia entails proportionate mechanical inconvenience, coupled with occasional dragging pains, nausea, or vomiting, and colicky flatulence, with disordered action of the bowels. Besides all this inherent discomfort, the hernial contents are liable to the accidental peril of inflammation, from injury by blows or other external violence, or from strangulation, on any occasion of unusual exertion. Omental hernia is less dangerous than intestinal protrusion, but there is always the risk of a piece of bowel slipping down and causing strangulation.

Treatment.—The indications are twofold: to prevent any increase of size, by additional protrusion; and the peril of inflammation thence arising, or from external violence. The support of a truss, with a large hollow pad for the protection of the hernia, will best fulfil these indications; but a very large hernia must be supported by means of a suspensory bag. Any violent exertion, or constipation, should be avoided as much as possible.

Reduction can sometimes be accomplished by diminishing the contents of the hernial sac. Mr. Bransby Cooper recommended a gradual course of treatment—confinement of the patient to bed for several weeks on low diet, with the continued application of ice to the tumour; and if it contain much omentum, the administration of small doses of blue pill and tartar emetic, in order to promote absorption of the fat. This plan has proved successful in some cases. Suspending the patient with his head downwards may induce the hernial contents to return into the abdomen. But the contents of an old hernia, when returned into the abdomen, may be a source of so much irritation, that any attempt at reduction, and especially by a mechanical and suddenly effective proceeding, should always be well considered.

Sometimes a hernia can be reduced, but cannot be kept up. This may be owing to long bands of adhesion to the interior of the sac, or partial adhesion to the neck; the protrusion returns when pressure is withdrawn; or, the sac having become partly inverted, the hernia descends again with the sac. The latter kind of reduction, observes Cloquet, is more likely to occur in femoral and direct inguinal herniæ; in oblique inguinal hernia, the connection of the sac to the spermatic cord, or the round ligament of the uterus, may prevent its inversion.

Inflamed Irreducible Hernia closely resembles strangulation, in its symptoms and treatment. If arising from any injury to the tumour, from a blow or other external violence, the peritonitis commencing in and spreading from the sac, may be subdued by rest and leeches, cold lotions, enemata and abstinence from food, with perhaps the administration of calomel and opium. In case of doubt, it will be safer to operate as for Strangulated Hernia.

Strangulation may supervene in an old irreducible hernia. This arises either from an additional protrusion, beyond what the hernial aperture had heretofore transmitted without strangulation, or from any cause of congestion of the pre-existing visceral protrusion which shall thus induce constriction of the neck. The symptoms are those of Strangulated Hernia, and the operation is imperative. In this condition the taxis cannot, I think, be trusted; for it is impossible to feel certain that a small knuckle of intestine, or a portion of the circumference only of the bowel, may not remain unreduced within a mass of irreducible omentum. I have met with such cases, and the strangulated intestine has been discovered by operation. Delay, in order to watch if the symptoms of strangulation should continue, might place the patient beyond recovery.

Incarcerated Hernia.—This term is intended to signify such imprisonment of the contents of a Hernia, itself irreducible, as shall obstruct the passage of fæces through the intestinal portion; but there is no impediment to the circulation—no strangulation.

The *Symptoms* are some increase of size and painful sense of weight in the tumour, without any tenderness or pain about the neck of the hernial sac; and this local condition is accompanied with constipation, and nausea or even vomiting. These symptoms have a chronic character, unlike those of strangulation.

Causes.—An accumulation of feculent matter or flatus in the fold of protruding intestine is the immediate cause of incarceration; but this is often preceded by constipation and the swallowing of hard, indigestible food. It occurs commonly in elderly persons, with large abdominal capacity.

Treatment.—The first indication is to excite the peristaltic action of the intestine, and this suggests the kind of remedial measures for removal of the obstruction; the patient remaining, of course, in the recumbent position. Aperient enemata answer best, and in particular a colocynth injection; purgatives administered by the mouth may operate beneficially, in the absence of vomiting. When some relief has been thus obtained, reduction of the intestinal contents may be advantageously attempted; any previous manipulation of the accumulation might tend to increase it.

STRANGULATED HERNIA.—Strangulation of a Hernia is said to have occurred when the protruded viscera—intestine, omentum, or both—are so constricted that, in addition to functional obstruction, as of the passage of feculent matter through the intestine, the vascular communication is also intercepted and the circulation of blood arrested,—a condition which soon leads to gangrene.

The state of the hernial contents of the sac, in the early and advanced stages of strangulation, have been already sufficiently described, in speaking of the general structural changes of Hernia.

Seat of Stricture.—Generally, the stricture is situated at the *neck* of the sac; but it may be either in the neck, by thickening of this portion of peritoneum; or external to and around the neck, by constriction of the surrounding tendinous or ligamentous structures forming the hernial aperture. These structures do not exert any active pressure upon the neck; the protruded viscus passes through an aperture too narrow for its reception, and, pressing outwardly, is resisted by the unyielding boundaries of that aperture. Hence, the precise seat of stricture may be in any portion of its circumference,—at whatever part resistance is greatest. This structural condition will be noticed more particularly in connection with special Herniæ. Occasionally, the stricture is situated in the *body* of the sac, which may have the form of an hour-glass contraction. Lastly, sometimes it forms *within* the sac; as a band of adhesion, or a band of thickened and adherent omentum, or there may be an aperture in the omentum constricting a portion of intestine.

Symptoms.—(1.) *Local.*—The tumour is irreducible, and the impulse on coughing is diminished or altogether absent, owing to the stricture preventing a transmission of the shock to the contents of the sac. The situation of stricture can sometimes be thus determined, as Luke pointed out, by observing the line where the impulse ceases to be felt. There is some enlargement of the hernial tumour, if a pre-existing one; or it may have recently made its appearance. It is tense and elastic, the more so if intestinal, and in proportion to the accumulation of serous fluid in the sac; but if omental, the tumour may still retain its characteristic doughy consistence. Tenderness soon supervenes about the neck of the tumour, and is thence diffused over the abdomen, which becomes painful and tympanitic as peritonitis is established. The pain varies in kind and degree. Usually referred more particularly to the umbilicus, there is a peculiar sensation of constriction across the belly, and perhaps a dragging-down sensation; or pain may be slight, or absent throughout. A constricted portion of *intestine* is functionally paralyzed, so that its peristaltic action is arrested. The fæces and flatus accumulate in the intestinal canal above the seat of stricture, and complete constipation ensues; although the bowel below may perhaps act once, and thus somewhat relieve the sense of colicky distension. Or, constipation may be incomplete, if only a portion of the canal of the bowel be constricted. Vomiting soon sets in; first, emptying the contents of the stomach, then throwing up bile and mucus, and lastly, the contents of the intestine,—the vomited matters acquiring a more or less decidedly feculent character. Yet, marked remissions of vomiting sometimes occur, as if there were no strangulation. *Omental* hernia is attended with similar symptoms, excepting that they are less severe, and the constipation is necessarily less marked. The symptoms of strangulation, in any case, are more acute if the hernia be recent and small, than if it be old-standing and large. Lastly, the position and respiration of the patient, as influenced by *peritonitis*, are peculiar. He lies upon his back with the knees drawn up to relax the abdominal walls, for the belly is tender, tense, and tympanitic; and the breathing is chiefly thoracic, in short, hurried catches, interrupted perhaps by hiccup,—always an unfavourable omen. (2.) *Constitutional* Symptoms.—Inflammatory fever accompanies the development of peritonitis, and is denoted by the ordinary symptoms—of a *sthenic* type in the young and vigorous, *asthenic* in the old and enfeebled. Usually, the pulse is quick, small, and hard or wiry, and prostration speedily supervenes; the pulse increasing rapidly in frequency to 100, 120, or more beats per minute, and becoming proportionately weak and irregular, as collapse succeeds. A cold, clammy sweat bathes the skin, and the expression of countenance is nipped and anxious; but there is often a notable relief of all the abdominal symptoms; the pain ceasing, the vomiting subsiding, perhaps even the bowels being relieved by an evacuation. Yet, in this deceitful state of tranquillity, the patient lies on the verge of death. Ultimately, with *gangrene*, the skin over the hernia may have acquired a dusky-red colour, and the tumour becomes doughy and emphysematous. Sometimes, with *rupture* of a sphacelated portion of intestine, fæcal extravasation takes place, when an accession of sudden and most intense pain betokens that perilous event; but the hernial *relaxation* coincident with sphacelus is a fatal omen, and in a state of overwhelming collapse, death occurs almost imperceptibly.

The *post-mortem* appearances presented by strangulated hernia are principally those of acute peritonitis. The abdomen is distended and tympanitic; and on opening the cavity, the intestines are found to be more or less injected of a bright-red colour, chiefly where the convolutions are in contact, where they are also agglutinated by yellow and tenacious recent lymph. A sero-purulent and flaky fluid has collected in the posterior recesses of the abdominal cavity; and there the intestine may show hypostatic congestion, of a dark venous colour—differing from peritoneal inflammation. The latter commences from the seat of stricture, where the bowel, lying just within the hernial aperture, still exhibits the mark of constriction; the nipped portion of bowel has a purple or blackish colour, and is adherent usually to the adjoining parietes. Above the stricture, the intestine is distended with flatus into large coils, which, on opening the abdomen, are first seen bulging up, and which conceal the relatively contracted or empty intestine below the stricture.

Diagnosis.—To determine the diagnosis of strangulated Hernia, a *tumour*, of hernial character, must always be sought for and discovered. But the size of such tumour is unimportant; a small hernial protrusion, embracing only a portion of the circumference of the intestine, will be quite sufficient to produce the most severe constitutional symptoms of Hernia. A patient may have suffered for some days from nausea and vomiting, with frequent desire to relieve the bowels, and inability to evacuate, passing only perhaps a little wind. The co-existence of a hernial tumour with these symptoms will complete the diagnosis. *Without* the presence of such tumour, similar symptoms may depend on mechanical obstruction of the intestine within the abdomen, and as arising from various causes—intussusception or invagination of intestine, volvulus or twisting of the bowel, the ligature of a fibrous band, the pressure of a tumour, stricture—simple or malignant—enteritis, or simply constipation. There are also the rare forms of internal abdominal hernia to be considered, in the absence of a tumour. A strangulated hernia being present, there may be a notable *absence* of the symptoms of strangulation,—local and constitutional. Thus, the usual tension of the tumour, and tenderness about its neck, may be wanting, and there may be no abdominal pain or tenderness on pressure,—even with pus-forming peritonitis; vomiting also may be absent throughout the whole course of strangulation; while the circulation and nervous system are, perhaps, singularly irresponsive to the local condition. Some quickness of pulse and anxious or haggard expression of countenance are, however, generally indicative of strangulation; and at length the patient succumbs to prostration.

The diagnosis of strangulated hernia from incarcerated, and from simply irreducible hernia, has been noticed in the definition of these several conditions of Hernia. *Inflamed* irreducible hernia most nearly resembles strangulation. Hernia in this state exhibits all the local signs, and excites the constitutional symptoms of inflammation. The combination of those indications which characterize the condition of strangulation does not, however, exist.

Peritonitis conjoined with irreducible hernia renders the diagnosis equivocal. But the peritoneal inflammation cannot be traced to the neck of the tumour as its origin and source, and it may be most intense at some distance from the sac; while the constipation and vomiting are not conspicuous symptoms.

In *double* hernia, both of which are irreducible, one may be strangulated, and the other not. Here the diagnosis must be determined by careful comparative observation; as to the local conditions of the two tumours,—in point of elasticity and tenderness of the neck, and to connect the abdominal and constitutional symptoms with one rather than the other, as their source.

Other tumours, compared with strangulated hernia, must be distinguished by their respective characters.

Causes.—Sudden protrusion of a viscus, as of intestine or omentum, by some violent exertion, is the common cause of strangulation. But it occurs in two distinct conditions of hernia. In a *newly formed* hernia, the protrusion takes place through a tight and previously undilated aperture, and the hernial contents rapidly become strangulated. In an *old-standing* and perhaps irreducible hernia, a larger descent than usual may take place, through an aperture then too small, although previously large, and the hernial contents gradually undergo strangulation. *Distension* of a pre-existing visceral protrusion, as of the intestine by fæces or flatus, and of the omentum by venous congestion, may occasionally induce strangulation. Spasm, formerly regarded as a cause, can scarcely have any effect; the hernial aperture being tendinous or ligamentous, or certainly not muscular, although indirectly subject to the action of the abdominal muscles. No *period of life* is exempt from the liability to strangulated hernia; it occurs in the newly born infant and in centenarians; but Mr. Bryant's collection of cases shows that the average age of persons suffering from strangulated inguinal hernia is forty-three, and from femoral fifty-five.

The *duration* of *pre-existent* hernia *before* strangulation happens varies, it would appear, considerably; the average period for inguinal hernia being twenty years, for femoral eleven years (Bryant). This fact indicates the liability of hernia to become strangulated at any time, however secure the individual may seem to be. And, not unfrequently, strangulation occurs on the occasion of the first descent; in femoral more often than inguinal hernia.

The *duration* of *strangulation*, before reduction or operation, has also been shown by Mr. Bryant to vary considerably, and in the two common forms of hernia; that the minimum period of strangulation is usually eight hours, and the maximum fourteen days; and that the average period of strangulation for inguinal hernia is 50½ hours, for femoral hernia 76½ hours. These facts throw light on the probability of a fatal result, consequent on the delay of reduction, and also after operation.

Treatment.—The indication is the removal of the constriction from the strangulated hernial tumour. This may be accomplished by gentle reduction of the hernial contents through the stricture; or, failing thus to fulfil the indication, then an operative proceeding for the division of the stricture must be had recourse to, without a moment's delay.

(1.) *The Taxis.*—This term signifies the manipulative procedure of reducing a hernia; it must be conducted on certain principles, and should be continued only for a certain time.

The principles are—to dilate the neck of the sac, and to diminish the bulk of the protrusion. In accordance with the former principle, the patient should be placed in the position requisite to relax any unfavourable muscular action on the neck of the tumour. The recumbent posture, with the knees drawn up and the body inclining forwards, will relax the abdominal muscles. With this view also, the patient's attention may be diverted by asking him questions occasionally during the attempt at reduction. The Surgeon steadies the neck of the tumour as far as practicable with one hand, while with the other he grasps the body of the tumour; when by a gentle, uniform, compressive manipulation, the hernial contents may be returned. The direction of the pressure is specially important; it should always be made in the course of the hernial descent. Slight traction downwards before using compression will sometimes facilitate reduction; apparently by freeing the contents from the neck of the sac. The taxis having been thus employed for a few minutes, any fluid in the sac may partially pass into the abdomen, accompanied with some diminution in the size and tension of the tumour; the flatus of the intestine may also escape into the intestinal canal above the stricture, accompanied with a gurgling sensation and sound, and then the intestine receding, goes up with a sudden jerk. Omentum may then have to be reduced, and this passes up gradually bit by bit, or a lump may slip up suddenly, as if intestine. Hence we cannot always determine by the taxis whether a hernia be intestinal or omental; and the less so as sometimes both parts go up together.

Dilatation of the hernial aperture, by insinuating the tip of the *finger* into it, is a manœuvre which has been successfully resorted to by Baron Sentin. It is most practicable in femoral hernia,—where the upper edge of the saphenous opening is sharply defined, and especially as felt in a thin person; or in inguinal hernia,—when the stricture is seated at the external abdominal ring.

The *amount* of compression justifiable, varies with the state of the strangulated intestine, as denoted by the one symptom—vomiting. Before this has occurred, the pressure should be gentle; after vomiting, any manipulation must be particularly delicate and cautious, lest the gangrenous bowel be irreparably damaged or burst. The *duration* of the taxis is equally important; for moderate but continued manipulation may be as damaging as a violent effort at reduction, and any such handling is more likely to induce inflammation. Half an hour may be roundly stated as the period beyond which the taxis should not be prolonged. The taxis should be regulated by the efforts which had been previously made to reduce the hernia; but, as neither the amount nor continuance of any such manipulation may be ascertainable, it will be better to err on the safe side of this question, rather than risk any further damage to the intestine. The *size* and *tension* of the hernia should also be taken into account. As a general rule—Hey observes—"the smaller the hernia, the less hope there is of reducing it by the taxis."

Further Measures for Relaxation.—If the taxis do not soon succeed, certain auxiliary measures may be resorted to with advantage; and, under such influences, reduction should be reattempted. The patient may be placed in a hot bath (96°—100° F.), and allowed to remain until some faintness supervenes, during which period the taxis is reapplied in the bath. This failing, he should be removed, and wrapped in blankets. Then chloroform may be administered cautiously, and under its influence another attempt at reduction be made, yet once more only.

It would be idle to even enumerate all the other measures which have been employed; some are pernicious, all are useless, with perhaps two exceptions. *Opium* may be administered with advantage in one period of strangulated hernia. When vomiting has commenced, and the stomach has been emptied by two or three vomits, there is—according to Mr. Birkett's careful observation—a short interval of repose, which continues until regurgitation takes place from the small intestines. If this moment be seized, and a full dose of opium in solution, with a little stimulant, be given, the hernia can sometimes be reduced. But when once the vomiting of regurgitated fluids has supervened, the inward administration of medicine is pernicious. Purgatives are positively killing, in thus attempting to force a passage through a strangulated portion of intestine; and enemata at least useless, with the view of emptying the lower bowel, already emptied by the irritation of strangulation above. Yet how often do we hear of or meet with patients who have been positively drenched with aperient medicines, followed up by enemata, for days or even a whole week, under the care of a chemist or possibly under medical supervision, before an operation for the relief of strangulation? This sad mistake arises mostly from overlooking the nature of the symptoms; the constipation and vomiting being regarded simply as a disorder of the stomach and bowels, without making any examination to discover a hernial tumour. Sometimes the essential pathology of strangulated hernia seems to have been misunderstood, as in a case alluded to by Mr. Birkett; an operation having been urged for the relief of a strangulated hernia, the gentleman in attendance immediately replied: "But will it not be desirable to wait until the vomiting has ceased before the performance of the operation?" *Cold applications* to the tumour, by means of the ice-bag or ether-spray, seem to have some advantage in facilitating reduction by the taxis. The blood-vessels being thus partially emptied, the bulk of the protrusion is somewhat diminished. But the tendency to gangrene will be increased by prolonged cold. Such applications are more useful as preventive of strangulation; and after strangulation has existed twenty-four hours, cold is inadmissible.

Injuries inflicted in the employment of the Taxis.—They affect separately, or in combination, the hernial contents, the sac, the integumental coverings. The nature of the injury is always the same—contusion or bruising, and the bowel may be lacerated or burst.

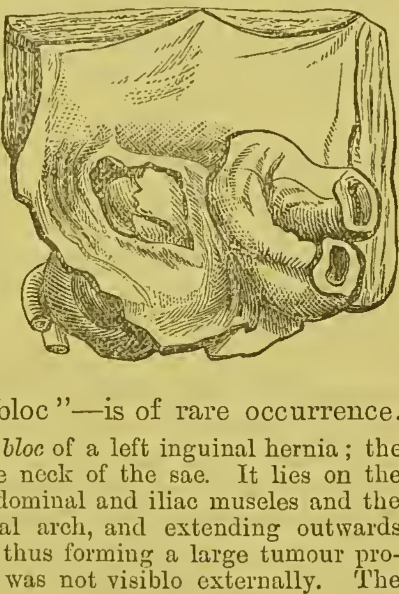
Thus, with regard to the *hernial contents*, intestine being most delicate, it is more commonly injured than omentum. Indeed, the latter may sometimes protect the former. The injury liable to be done to the bowel should be estimated less by the symptoms of strangulation than by the violence and prolongation of the attempts employed in the taxis. After the first act of vomiting, and during the succeeding twenty-four hours, the bowel may be killed by manual pressure, or cut by pressure against the hernial aperture. In either case, the entire calibre of the bowel becomes divided, at length forming an artificial anus; or death takes place in consequence of feculent extravasation backwards into the abdomen. After the expiration of twenty-four hours, the softened state of the bowel will probably cause it to yield under any violent or prolonged use of the taxis. Rupture usually occurs at the convex border of the gut, at the furthest point from the mesentery, and the rent is in the direction of the circular muscular fibres.

The *signs* of burst bowel are very significant. If an enterocele, the bowel glides away from the pressure of the finger and the tumour disappears. But this apparent reduction is not accompanied with that sudden and peculiar gurgling subsidence which attends the return of an unburst bowel into the abdomen. The patient immediately complains of intense pain in the abdomen, vomiting ceases, succeeded however by retching and hiccup, with utter collapse and death. Sometimes, inflammation and suppuration take place in the sac, and extending through its coverings, the abscess bursts, forming a fistulous communication with the interior of the intestine. Some hæmorrhage into the sac may also have been caused by the violence of compression, producing a mixture of blood and coagula with the flakes of lymph and pus which result from inflammation.

The hernial *sac* is subject to two forms of injury: displacement, and laceration or rupture. Both may happen together, and almost necessarily in connection with considerable force.

By *displacement*, the sac is detached, to a greater or less extent, from the surrounding textures. This injury occurs usually in inguinal hernia. The neck of the sac is more frequently affected than any other portion. It becomes detached from the inner surface of the internal abdominal fasciæ, and carrying with it the surrounding portion of parietal peritoneum, a pouch is thus formed within the fascial membrane of the abdomen; into which the hernia may be forced, and being retained therein, is lost to touch and sight. (Fig. 781.) Sir Charles Bell recorded another case of injury, in the "London Medical Gazette," 1828. The entire hernial tumour may be pushed into the abdomen, in a mass; the tumour disappearing, whilst the contents are still strangulated by the mouth of the sac. This injury—first described by Le Dran, as "réduction en bloc"—is of rare occurrence.

FIG. 781.*



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* Roy. Coll. Surg. Mus. 1293. Reduction *en bloc* of a left inguinal hernia; the intestine remaining tightly strangulated by the neck of the sac. It lies on the outer side of the internal ring, between the abdominal and iliac muscles and the peritoneum; part of it being below the crural arch, and extending outwards nearly to the external iliac vessels. The sac, thus forming a large tumour projecting inwards towards the abdominal cavity, was not visible externally. The patient, a man aged fifty-three, had been the subject of inguinal hernia for years, without inconvenience, having always worn a truss; after having become tense and painful, the hernia was completely reduced, but the symptoms of strangulation increased, and terminated in death on the fifteenth day. (John Taunton.)

Mr. Luke's paper in the "Med.-Chir. Trans.," 1843, will give further information.

By *laceration* of the sac, commonly in its neck along the posterior aspect, the hernial contents escape through the rent into the sub-peritoneal connective tissue. Under continued pressure, the hernia still passes backwards, and, by detaching the neighbouring peritoneum, gets lodged between that membrane and the internal abdominal fascia. This injury is more frequently produced in that variety of inguinal hernia known as congenital, or its sub-form, infantile hernia. It is inflicted very easily under the influence of chloroform, and especially in a youthful patient.

The *signs* are these:—the tumour becomes smaller and flaccid, slowly diminishing as the pressure is continued until it almost disappears; but as the hernial contents escape, the Surgeon fails to feel the well-known sensation of a gurgling jerk produced by the return of bowel into the abdomen, and the direction of this apparent reduction seems wrong. Symptoms of strangulation recur, and perhaps with aggravated severity; the tumour also may reappear, and recede again under the application of slight pressure.

The *coverings* of the hernial sac are liable to injury from rough handling; contusion produces ecchymosis of the integument, with perhaps subcutaneous extravasation of blood and œdematous infiltration, or inflammation, leading to suppuration and sloughing.

Symptoms after Reduction.—Vomiting ceases usually, or it may continue for a while as the effect of chloroform. The pain in the abdomen and sense of constriction are immediately relieved, and soon pass off.

Persistence of the symptoms of Strangulation, after *apparent* reduction, may arise from three conditions of injury: rupture of the intestine, with feculent extravasation into the abdomen; displacement of the sac into the abdomen, or reduction *en bloc;* rupture of the sac, and apparent return of its contents. These conditions—thus agreeing in the disappearance of the tumour—may perhaps be diagnosed by their structural modes of production, already noticed. Certain conditions of the hernia itself, after *real* reduction, may also perpetuate the symptoms; such as internal stricture—within the sac, reduction having overcome only the external stricture of the hernial aperture; or persistent constriction of the viscus which had been protruded, as the result of plastic effusion forming a peritoneal band. The still strangulated viscus remains functionally paralyzed,—the bowel not regaining its peristaltic action, and the constricted portion becomes gangrenous; with unabated continuance of peritonitis, constipation, and vomiting as the symptoms of strangulation. Only a *portion* of the circumference of the intestine may thus remain constricted or indented; a condition which I have seen in a certain number of cases, two of which I examined more particularly. This nipped portion may give way some days after operation; ulceration of the mucous membrane of the bowel having taken place, followed by rupture of the peritoneal coat, either as a large rent or in numerous minute apertures (Spence). The symptoms are the same, though perhaps less marked than with complete constriction. In both conditions of persistent strangulation, when rupture of the bowel occurs, overwhelming peritonitis rapidly ensues.

The *treatment* of these various misadventures of the taxis may be conducted on one and the same general principle. With *persistent* symptoms of *strangulation*, after apparent or after real reduction, an operation must be resorted to, with the view of reaching the still existing seat of stricture and dividing it. Care must be observed to modify the operative procedure according to the structural conditions of the hernia, as already described; especially in regard to the apparent reduction arising, either from displacement of the sac into the abdomen, or from rupture of the sac externally. Should the bowel remain constricted after its reduction, of course no stricture would be discovered by operation.

Any temporary continuance of the symptoms of strangulation, due to previous constriction, must not be mistaken for persistence, due only to a persistent cause. Their gradual subsidence or continuance, the case being watched from hour to hour, will probably enable the Surgeon to determine as to the necessity for operative interference.

(2.) *Operation for Strangulated Hernia.*—Herniotomy.—The Taxis having failed to effect reduction, an operation for the removal of the impediment to reduction, by division of the stricture and liberation of the protruded viscus, should be resorted to without a moment's delay. The general indication as to the *absolute necessity* and *extreme urgency* of this operation may be thus stated:—persistent vomiting, and especially of a feculent character, showing the regurgitation of the contents of the small intestine.

The taxis must be forthwith abandoned; or, if not previously tried, it should be gently tried only once under the immediate administration of chloroform; and that attempt failing, any further delay of operation would be attended with hourly increasing peril. According to the results of Mr. Luke's experience, of 69 cases of strangulated hernia operated on within the first forty-eight hours of strangulation, 12 died, or 1 in 5·7; whereas of only 38 cases operated on after more than that period had elapsed, 15 died, or 1 in 2·5,—showing a fast increasing proportion. This large mortality is due, not to the operation, in itself, but to the state of the hernial contents when operated on. Gangrene will have almost inevitably supervened, and aggravated probably by repeated attempts at manipulative reduction. Two maxims, by Surgeons of large experience, may serve to impress on the mind the danger of prolonged taxis, and of the delay of operation. Desault observed—"Think favourably of a hernia which has not been handled before operation;" and Mr. Hey confesses—"I have often had occasion to lament that I performed the operation too late, but never that I had performed it too soon." For even at very early periods—in rare, yet authentic cases—gangrene of the hernial protrusion has been known to follow the symptoms of its strangulation,—in only two hours, in eight hours, in ten, and in twenty-four hours. Whenever, therefore, the taxis has failed, and perhaps vomiting is persistent, the operation must be resorted to at once, under the influence of chloroform,—which will have been already administered in the case of a first and only attempt to accomplish reduction by taxis at the extreme period of urgency. But at any period of strangulation, however advanced, operation is justifiable, and should be tried—says Lawrence—if the patient has strength to go through it; for recovery has sometimes followed under circumstances apparently almost desperate.

Modes of Operation.—Two modes of performing the operation are generally applicable; either by opening the hernial sac, exposing its contents, and dividing the stricture, wherever situated, *within* the sac; or by dividing the stricture *outside*, leaving the sac unopened,—as was originally performed by Petit in 1718, and reintroduced by Aston Key (1829), and Luke (1831). Of the two latter authorities, the one wrote an admirable memoir "On the Advantages and Practicability of Dividing the Stricture in Strangulated Hernia on the Outside of the Sac," 1833; the valuable paper of the other appeared in the "Med.-Chir. Trans.," vol. xxxi. M. Guérin has divided the stricture subcutaneously, as described in the "Gaz. Méd. de Paris," Aug., 1841.

Conditions for choice of either Operation.—That of not opening the sac is always preferable, from its comparative safety and simplicity, whenever it will probably be effectual for the relief of strangulation and reduction of the hernia. The guiding principle of choice may perhaps be thus enunciated:—whenever the symptoms are of such moderate severity that the hernial contents might be safely returned by taxis—were it practicable—any existing stricture outside the sac may be divided and the hernia reduced; on the contrary, whenever the symptoms are of such severity as would indicate a state of the bowel, especially, which would be hazardous to attempt to reduce by taxis, the sac must then be opened. Hence, Mr. Birkett would define the following to be the principal conditions that should determine this election: —For not opening the sac,—that the symptoms of strangulation have existed only a few hours and have not been very severe, the vomiting not stercoraceous, nor prostration extreme, the hernia a simple enterocele, and which has not been subjected to forcible attempts at reduction; for opening the sac,—prolonged strangulation, stercoraceous vomiting and marked prostration, the hernia compound—an entero-epiplocele, and which has been subjected to repeated, protracted, or forcible taxis. Duly comparing these opposite conditions of operation, it will appear that the number of cases of strangulated hernia eligible for operation, without opening the sac, is unfortunately very limited.

In old-standing hernia, and of large size—as many scrotal herniæ—the stricture should always be divided, if possible, without opening the sac; for the exposure of so large a peritoneal cavity, and the division of adhesions, would almost certainly be followed by fatal peritonitis. The protruded viscera had better be left within the sac, rather than returned into the abdomen, which has become unfitted to accommodate them, and where the hernial aperture will probably be so large that they cannot be kept up.

The *relative results* of both modes of operation may be gathered sufficiently from the following statistics:—Out of 84 cases of hernia operated on by Mr. Luke, in 25 the sac was opened, and 8 died; whereas, in 59 the sac was not opened, and only 7 died. The additional cases reported by Mr. N. Ward give a total of 36 deaths in 153 cases of Petit's operation. On the other hand, of 77 cases reported by Sir A. Cooper, in which the sac was opened, 36 proved fatal; and of 545 cases collected by Dr. Turner, 260 died. Regarding *femoral* hernia in particular, where the stricture is commonly outside the sac, of 31 cases operated on by Luke, in 7 only was it necessary to open the sac. Inguinal hernia cannot generally be relieved externally; of 20 cases operated on by the same Surgeon, in 13 it was necessary to open the sac.

(*a.*) *Operation in which the sac is opened.*—The *instruments* required are few and simple—a scalpel with a single-cutting edge; dissecting-forceps; directors, straight and *curved;* Key's *broad* hernia-director; bistouries, blunt-pointed, straight and curved, for dividing the stricture, or Sir A. Cooper's *hernia-knife;* retractors. It will thus be seen that the only peculiar instruments are the hernia-director and the hernia-knife.

The *operation* consists in exposing and opening the sac, finding and dividing the stricture, the management of adhesions, and the visceral protrusion. The patient lying down on the edge of the bed or table, with the part well exposed, the bladder is emptied and the hair shaved from the seat of operation, in the ordinary inguinal and femoral herniæ. An incision is then made, of sufficient length, over the neck of the tumour, by pinching up a transverse fold of integument and transfixing with a scalpel through its base; the back of the knife being turned towards the hernia, the edge is made to cut outwards through the fold of skin. On letting go the fold a linear incision is presented in the direction of the neck of the tumour, which may be extended at either end as occasion requires. The cellular texture and fat are then carefully divided on a director, or by a scratching dissection with the scalpel and forceps; this precaution will be necessary, as the integumental incision may have almost at once exposed the sac, so little is there seen of the separate layers or coverings of hernia as distinguished in the diagrammatic descriptions given in anatomical works. An anatomical or inexperienced operator may make as many layers of covering as he pleases; and with no harm to the operation, but perhaps with safety to the patient. Any small bleeding artery had better be secured by a twist with the forceps, lest it should obscure a clear view of the sac. This will be recognized by its tension and whitish appearance; thin and translucent, and often coloured from the hernial contents, in recent hernia; thick and opaque white, and not transmitting any colour, in old hernia. *To open the sac*, a little bit should be pinched up with the forceps, and by a slight rotation having ascertained that no portion of intestine is included, the knife is laid flat and a small button-hole aperture made under the point of the forceps; usually, but not always, a little serous fluid will escape, having a yellowish or brownish colour, according to the state of the hernia, and a small bleb of glistening intestine or a bit of granular fatty omentum, more or less darkened in colour, may rise up through the aperture in the sac. A director is introduced, and care taken that it lies entirely between the gut and the sac, no portion of bowel overlapping. This can perhaps be plainly seen through the more translucent peritoneal sac of a recent hernia; but with an opaque sac, it will be advisable to use the broad director as a safeguard. Then, introducing a probe-pointed bistoury along the groove of the director, the sac is slit up towards its neck—the usual seat of stricture; and turning round the instrument, a slit is made towards the fundus, so as to thoroughly expose the hernial contents. A practised operator will perhaps prefer the finger to a broad director, and I almost habitually use it as such instead.

The seat of stricture is sought for by gently examining the visceral contents of the sac. Situated commonly at the neck of the sac, the protrusion is there constricted and pedunculated. The stricture will, therefore, not generally be visible, but it can be easily felt. Before passing the forefinger of the left hand up to the neck of the sac, the body of the hernia, including both the sac and its visceral contents, should be gently steadied with the other hand, in order not to drive the neck before the finger. At the same time, the finger is passed up and its point slightly inserted, as a protector, between the protrusion and the stricture. Then, using the finger as a director, the blunt-pointed hernia-knife is slipped up along the curve of its palmar surface, and just sufficiently far to bring the cutting edge of the knife under the stricture. When the stricture is very tight, I am in the habit of insinuating the nail of my finger—preferably to Stanley's curved stricture-director—and then slide the hernia-knife flatwise over the back of the nail. Or, it may be more convenient to pass the knife along the curve of the finger. On gently elevating the handle, the stricture yields with a creaking sound; but it should be divided to a very limited extent, from one-eighth to a quarter of an inch, or just sufficient to admit the point of the finger to pass on into the abdomen when the knife is withdrawn. The *direction* in which the stricture should be divided varies with the hernia, and will be particularly noticed in describing the operation as performed for inguinal and femoral herniæ. Serous fluid may now escape from the abdomen, varying in quantity from a few drachms to some ounces, and thus indicating the intensity of the abdominal peritonitis.

Reduction of the visceral protrusion is determined by the state of the parts. They should be carefully examined to discover whether there are any adhesions either between the parts, or between them and the sac; and to ascertain also whether the protruded parts and the seat of constriction are in a sufficiently healthy state for reduction.

If the hernia be, as usual, an entero-epiplocele, the intestine will probably be seen, or more entirely, on drawing aside the omentum. Provided both be healthy and without adhesions, the intestine should be gently drawn down, to see that the constricted part also is not gangrenous, and to efface the indentation which otherwise might remain; then, reduction is effected by a gentle kneading action with the fingers to empty the gut and replace it, followed by a similar manipulation to replace the omentum. Larger portions of either may be returned, bit by bit, from one end adjoining the hernial aperture and followed gradually to the other end. In concluding the operation, the point of the finger should be gently introduced into the abdomen, to feel that the mouth of the sac is free, excepting in those unusual cases where the bowel or omentum is allowed to remain unreduced. The *bulk* of intestine, owing to its quantity and distension with flatus, will sometimes render the reduction of the whole mass impracticable. In one such case, Mr. Tatum punctured the bowel with a grooved needle, and allowed the flatus to escape. The result was completely successful, but the justifiability of this instance as a precedent may well be questioned.

Adhesions must be dealt with according to their nature and connection with the bowel or omentum. As to the *bowel*, *recent* adhesions may be gently separated with the finger, between a coil of bowel, or between it and the sac; *old* adhesions may be divided with the knife, when thread-like, but when close and extensive their division would run the risk of injuring the bowel. Scarpa affirms that the adherent portion of intestine is gradually drawn up to, and even within, the hernial aperture—the stricture having been relieved. *Omental* adhesions may be divided a little more freely, or a small portion of omentum may even be left adherent to the neck of the sac.

With a *gangrenous condition* of the intestine and omentum, the state of the *bowel* will determine the propriety of its reduction, or of the formation of an artificial anus. Gangrene short of sphacelus is not irrecoverable, and this more favourable condition is indicated by the bowel, however approaching to black, still retaining its peritoneal lustre and smoothness; provided the constriction of the strangulated part can be effaced by gentle manipulation, without damaging the bowel when thus affected. A nipped state of the bowel, when returned, would probably be followed by sphacelus and sloughing, with the formation of an artificial anus. When the blood-vessels can be distinguished, if they fill again, after gentle pressure between the thumb and finger, the Surgeon will be assured that the circulation has not stopped. In this state, the bowel may be returned just into the abdomen, where it will perhaps recover itself; or in the event of sloughing, the aperture may be closed by peritoneal adhesion, and the slough pass into the intestinal canal without fæcal extravasation; or the fæces and slough will escape through the wound, as the most unfavourable issue. Mr. Aston Key advocated this procedure. *Sphacelus* is of course irrecoverable, and the only difference of opinion is as to the propriety of dividing the stricture. Division has been said to be unnecessary or even injurious, and such was the opinion of Lawrence and Travers; on the other hand, division of the stricture was advocated by Sir A. Cooper, Key, and Dupuytren; but also that the bowel should not be returned, and a free incision made into it to allow the discharge of fæces through the wound. The liability of some portion of fæcal matter to pass backwards into the abdomen, and thus induce more acute peritonitis, is, however, a serious consideration. Professor Spence, therefore—having divided the stricture freely—draws the gangrenous portion of bowel downwards beyond the constriction into the wound, and there leaves it for some hours, until the passage into the abdomen is defended by effused lymph; then he makes an incision, or rather cuts off the gangrenous portion. If the gut has already broken, a similar proceeding will be appropriate; division of the stricture, and the bowel left unreduced in the sac. In this state also, adhesions, consequent on peritonitis, form around the stricture at the neck of the sac; and by thus retaining the bowel in position, and preventing feculent extravasation backwards into the peritoneal cavity, an artificial anus becomes established.

The state of the *omentum*, and the quantity of it protruded, will determine with regard to this structure the propriety of its reduction; or of leaving it in the sac, or removing it. Gangrenous omentum should certainly not be returned into the abdomen; and inflamed omentum with extensive adhesions is equally unfit for reduction. But a large mass of protruded omentum, or an omental protrusion which has become hypertrophied, indurated, or otherwise changed in structure, as in old herniæ, are conditions in which, if returned, it would excite peritonitis. The omentum must either be left in the sac, or removed. If left in the sac, the advantage and disadvantage are these:—Usually, the omentum shrinks up, and eventually the wound heals, but with more or less of a tumour remaining at the hernial aperture;

a condition which may prove useful in plugging up the aperture, although it will interfere with the efficient application of the pad of a truss. Or, the omentum is liable to become inflamed, to suppurate and slough; delaying considerably the healing of the wound. The safer practice, therefore, is to excise the protruding portion, rather than encounter the risk of leaving it. *Ligature* of the mass is always necessary; both to prevent the risk of hæmorrhage from the highly vascular omentum, and the peril of extravasation backward into the peritoneal cavity, beyond the reach of surgical interference, and which would be provocative of peritonitis. The mass may be ligatured by means of a single ligature of whipcord or catgut, tied tightly round the neck, or passed by transfixion, the loop divided, and each half tied separately; or the omentum may be ligatured in successive portions, so as to tie the vessels separately. The one proceeding was formerly supposed to have the disadvantage of inducing peritonitis by constriction of the omentum; an evil consequence which has, however, been disproved by the results of more recent experience. Of twenty cases of hernia, at St. George's Hospital, in which the omentum was securely tied, a few died; but post-mortem examination showed the cause of death to have been, in all cases, independent of the ligature. But ligature of the vessels singly has the advantage of more surely preventing hæmorrhage, when the ligatures become detached. In my own practice, I distinctly lost a patient owing to the uncontrollable hæmorrhage arising from the separation of a single ligature around the omentum *en masse*. Excision should be performed close to the external aperture; care being taken to leave the stump of omentum in the aperture, and to secure it there by fixing the ligature cord or cords with a strip of plaster on the adjoining part of the abdomen. The stump, thus occupying the orifice, is free in the event of hæmorrhage, and it forms a plug which permanently obstructs the descent of a hernia, and which is quite as effectual as when the whole mass is left. Ligature and excision of the omentum must always be very carefully performed; before applying the ligature, the omentum should be unfolded to see that it does not envelop a knuckle of intestine, and in using the knife, care must be taken not to touch the bowel. In a case of femoral hernia—entero-epiplocele—I removed a portion of omentum, the size of a hen's egg, and which weighed 1¾ oz. But larger portions, even five and six ounces, have been taken away with safety.

The formation of a regular "omentum sac" around the intestine is described by Mr. Prescott Hewett, in the "Med.-Chir. Trans." of 1844, and in the "Path. Trans.," vol. iii.

Cysts, containing serous fluid or blood, are occasionally met with in the omentum; they resemble a knuckle of intestine. Their nature having been ascertained, the fluid may be discharged by puncture. The omentum is then managed according to the rules already laid down.

Accidents in the Operation.—*Wound of the intestine* happens occasionally; this accident occurred in the skilled hands of Sir A. Cooper, and in those of Sir W. Lawrence, Liston, Jobert, and J. Cloquet. It is liable to happen in either stage of the operation; in opening the sac, or in dividing the stricture. The one occasion of accident may generally be avoided by observing the precautions enjoined, in opening the sac; and the other by equally protecting the gut, in dividing the stricture. The escape of flatus and fæces will at once declare the nature of the accident; although of course, the same discharge occurs when the gut yields by laceration from handling it in a soft and gangrenous state.

The *treatment* of wounded intestine is simple. A puncture may be secured by seizing the point with forceps, and casting a fine silk ligature around it, the ends of which should be clipped off close. An incision may be closed by the glover's stitch. In either case, the bowel is then to be returned just inside the mouth of the sac. The case proceeds the same as in a wound of the abdominal parietes involving the intestine; and the result is not unfrequently successful, or the bowel giving way, an artificial anus forms.

Wound of an artery.—In dividing the stricture, an artery may be wounded, either as a sheer accident, owing to some anomalous course of the vessel, or from dividing the stricture in a wrong direction. The accident is more liable to happen to the deep epigastric or the obturator arteries, in the operations for inguinal and femoral herniæ.

Treatment consists in at once cutting down upon and securing the bleeding vessel; an injunction easier given than carried out. As a precaution against such an accident under any uncertain circumstances, I am accustomed to elevate the handle of the hernia-knife, so as to divide or notch the stricture somewhat more externally than internally—towards any unusual relation of an arterial vessel; observing also to divide only to such a limited extent as may be requisite to return the hernial protrusion, when disengaged, by gentle manipulation.

Inflammation and *suppuration* of the sac has been known to follow herniotomy, in which the sac is opened; a consequence of this operation to which Mr. Key, particularly, has drawn attention. It is more liable to happen after the operation for scrotal hernia, the sac being of large size. In a few days the scrotum becomes distended and tender; and as these symptoms are accompanied with constipation and sickness, the Surgeon might suppose that the hernial protrusion had returned. He is soon undeceived by the escape of some purulent matter, which must then be allowed to have a free discharge, favoured by poulticing.

Sloughing of the sac seldom occurs; it usually terminates fatally, occasionally in recovery. I have only seen this complication once,—in an old inguinal hernia, with a thick sac, and of large size; the wound reopened, the sac sloughed, and the patient died.

(*b.*) *Operation without opening the sac.*—This modification of the operation of strangulated hernia is performed in precisely the same manner, short of opening the sac. The circumstances under which this limited operation would be advisable have been already enumerated. The stricture is divided externally, by means of a probe-pointed bistoury; and the contents of the sac reduced by compression, followed, in a recent hernia, by the sac itself. In fact, the taxis is reapplied to the sac, now that the stricture is divided. That failing, there is no alternative but to open the sac, and complete the operation in the usual manner. And it is safer to do so, if there be any doubt as to the state of the visceral contents, or if much compression be requisite.

Either modification of the operation (*a* or *b*) for strangulated hernia is concluded, by bringing the line of incision in the integument together by two or three points of suture and strips of plaster; over which a pad-compress of lint should be applied, retained by a bandage, to prevent any re-descent of the hernia. It is well, however, to leave the lower angle of the wound open, to allow of the escape of bloody serous fluid. The sutures should not pass through the sac, and if the latter be of such size and thickness as to prevent the easy closure of the incision, a portion of the sac may be removed for this purpose. When the sac is left occupied, and it is sought to establish an artificial anus, or such an opening has formed, the wound must be allowed to remain open.

Treatment after Operation.—The general indications are—to restore the healthy state of the intestine and omentum, and to prevent or manage inflammation supervening as peritonitis,—and as complicated with a penetrating wound of the abdomen and a reduced state of the constitutional powers, in consequence of continual vomiting, starvation, suffering, and alarm.

Two principles of treatment have been adduced, of opposite character; and both having been advocated by Surgeons of the highest eminence, they each demand notice.

In the one class are those Surgeons who administer purgatives almost immediately after the operation, and persist in their continuance "until the intestinal canal is completely unloaded." Calomel, castor oil, extract of colocynth, and sulphate of magnesia are administered by the mouth, and enemata per rectum. This plan of after-treatment was strongly advocated by Lawrence and Velpeau.

Another, and as I think a far more judicious class of practitioners, relying on the restorative power of nature—the strangulation having been relieved—have but little recourse to medicine. Care is taken to leave the intestine at rest for some days to recover itself, and that the diet be light and unirritating, in the shape of farinaceous food and milk; while opium is had recourse to as occasion may require. Accordingly, this plan of treatment may be generally stated in the following order:—The patient is placed on his back in bed, and not disturbed by talkative friends. Soon after the operation, a full dose of opium—thirty drops of the tincture—will be advisable. At this period, brandy-and-water may be given with advantage, in small quantities at intervals, as a stimulant; to recover the circulation from the state of prostration or collapse previous to the operation, and the effect of chloroform. The *bowels* will probably be relieved naturally within the first twenty-four hours. But if not, they may be allowed to remain inactive for three or four days, when a mild enema of gruel and castor oil, or salt and water, will be sufficiently laxative. Great distension and discomfort may justify relief at an earlier period; but cases not unfrequently proceed even to the healing of the wound without any intestinal action, and no evil consequence from the constipation. The diet, light and unirritating, must be given in small quantities at short intervals; the object being the support necessary for reparation without loading the intestine. Thirst, often a distressing symptom, will be greatly allayed by sucking pieces of ice in the mouth.

Peritonitis supervening, is denoted by the usual symptoms of pain in the neck of the sac, spreading over the abdomen; this must be met by leeches, warm fomentations, and the ordinary treatment of peritoneal inflammation; in its acute and sthenic, or its chronic and asthenic forms. This plan of treatment must, therefore, be modified according to the opposite conditions of youth and age, strength and decrepitude, temperance and intemperance, and the peculiarities of the individual. I have known peritonitis after herniotomy to be attended with singularly persistent abdominal symptoms, such as tenderness and tympanitis, yet without any notable constitutional disturbance.

The *wound* may heal partially or entirely by primary adhesion. But if inflammation and suppuration ensue, the sutures should be withdrawn, here and there, to allow of the free escape of discharge. Healing then takes place by granulation and cicatrization. When the patient gets up, he should wear a truss for some time, to support the part as yet in a weakened state. It may be disused, when there is no tendency to protrusion on coughing or other exertion.

The *prognosis* of strangulated hernia, in regard to the *mortality* after operation, will be determined; partly by the relative statistical results of operation, with reference to opening or not opening to the sac, as already shown; but principally by consideration of the previous duration of strangulation, and the taxis to which the tumour has been subjected. The influence of strangulation has been shown by Luke's statistics, as to the results of operation for Strangulated Hernia.

Duration of life after Operation.—In 20 fatal cases operated on by Mr. Birkett in Guy's Hospital, the *periods of survival* were as follows:—

1 survived only 17 hours.
5 ,, 24 hours, and less than 48 hours.
4 ,, 48 ,, ,, ,, 72 ,,
1 ,, 72 ,, ,, ,, 96 ,,
1 ,, 96 ,, ,, ,, 120 ,,
3 ,, 144 ,, ,, ,, 168 ,,
1 ,, 168 ,, ,, ,, 192 ,,
3 survived longer periods, but with artificial anus.
1 died of bronchitis.

In Bryant's collection of 126 cases, more than half the patients died within 48 hours, the second day being most fatal; and four-fifths died within the first week.

The *causes* of death were (Birkett's cases):—

Artificial anus, etc. . .	3	Perforation of bowel . .	1
Prostration	5	Bronchitis and cachexia .	2
Acute peritonitis . .	8	Neglect to seek surgical aid	1

Two-thirds, at least, of these patients lost their lives by the previous delay of operation for the liberation of the bowel; although this was done as soon as possible after admission to Hospital.

In 26 fatal cases, out of 127, operated on by Professor Spence, the causes of death were:—

Gangrene of bowel	17
Peritonitis, which had commenced prior to operation. Four of these were congenital herniæ	7
Pyæmia, fatal on 8th day	1
Melæna	1
	26

The Period of life has, of course, some influence, favourable or unfavourable, relative to the results of operation. But either extreme of age may recover. In two cases,—the youngest and the oldest patient operated on by Professor Spence,—an infant between eight and nine months old, and a woman aged ninety-eight years, both recovered.

Relative mortality of Strangulated Herniæ.—In 127 cases (Spence):—

	No.	*Recovered.*	*Died.*
(1.) Inguinal	46	38	8
(2.) Femoral	77	60	17
(3.) Umbilical and ventral	4	3	1
	127	101	26

It thus appears that the proportionate mortality was:—(1) nearly 1 in 6; (2) between 1 in 4 and 5; (3) 1 in 4. But this estimate is subject to two sources of inaccuracy: the obvious difference in the number of cases compared, and the unknown periods of strangulation prior to operation.

ARTIFICIAL ANUS.—This condition is said to exist whenever an aperture forms, or is made, in the intestine, through which its contents escape externally. The state of the bowel is, usually, gangrenous; whereby it may have yielded in the sac before operation, or afterwards, although returned into the abdomen; or it may be purposely laid open in the operation, to allow of the escapes of fæces when that issue is inevitable. A healthy portion of intestine may, however, be accidentally wounded, in the course of operation, or by a penetrating wound of the abdomen. Rarely, a fæcal opening results from ulceration of the intestine, involving the abdominal wall. Artificial anus occurs most frequently in the inguinal, scrotal, and femoral regions; and in connection with the small intestine. The kind of discharge will depend on the part of the gut opened, and its quantity on the size of the aperture. But digestion is more or less imperfect; hence the nutrition and general health of the person becomes impaired.

Generally, an artificial anus forms *after* operation,—the bowel having been returned into the abdomen. The probability of its occurrence will depend very much on the advanced state of gangrene,—short of sphacelus, in which case the bowel would not have been returned. But the state of gangrene itself depends principally on the tightness of the stricture to which the bowel has been subjected, as well as the duration of the strangulation. The deeply constricted appearance of the strangulated part will indicate the probability of sphacelus supervening,—and thence of artificial anus. Commencing at a variable period, after operation,—some hours only, or a few days, perhaps even some weeks,—the wound reopens, at least in part, and the dressings are seen to be soiled with feculent matter, while the opening emits a gangrenous fæcal odour. The discharge increases, and becomes continuous, until an artificial anus is established.

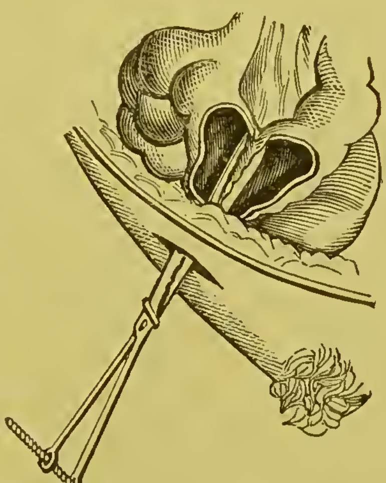
Artificial anus differs according to the *extent* of aperture; either as a sloughing perforation in the bowel, or sloughing of the entire circumference of the canal. Sloughing perforation usually takes place about the centre of the convex free border of the knuckle of intestine,—at a point most distant from the mouth of the sac; a small ulcerated opening is produced, which does not interfere with the continuity of the intestinal canal, although allowing a portion of its contents to escape. This condition is sometimes distinguished as *fæcal fistula.* Sloughing of the entire circumference of the intestine usually occurs at the mouth of the sac; the continuity of the canal is destroyed, and all the feculent matter escapes through the opening. The coats of the bowel are endowed with different powers of resistance to the process of ulceration whereby the slough is detached. Thus, by constriction of the bowel, a sulcus or groove is produced on its serous surface, without any trace of abrasion; but the mucous membrane presents a circular line of ulceration. This is sometimes limited to the upper and distended end of the intestine; the lower end, corresponding to the stricture, being unaffected. This difference may be owing to pressure of the distended bowel, and it occurs particularly where the knuckle of intestine lies in close relation with Gimbernat's ligament. Very rarely, as the result of long-continued constriction, and the pressure upon two portions of intestine laterally, their walls become adherent; ulceration follows, and the continuity of the canal is thus naturally restored within the abdomen. An illustrative case is recorded in the "Trans. Path. Soc.," vol. x.

Intermediate conditions, between these two extremes, are met with; in which more or less of the circumference of the tube is destroyed, and a corresponding opening produced.

In the first condition referred to, repair frequently takes place; the hole closes, the integument heals, and complete recovery results.

In the second condition, frequently, an artifical anus is at length established; and which never, or very rarely, undergoes spontaneous cure. Its completion is as follows:—The margin of the intestinal aperture—whether the whole or a portion only of the calibre of the intestine—becomes firmly adherent to the abdominal peritoneum; the openings of the upper and lower end of the canal are, at first, equal in size and lie nearly in the same line. Subsequently, they unite at a more or less acute angle, presenting an intermediate spur-like portion or partition, of double-walled gut, opposite the mesenteric attachment, and bisecting the aperture externally. (Fig. 782.) Of these two openings thus leading into the canal, the distal one, gradually ceasing to transmit fæces, becomes smaller, and the portion of intestine atrophies; whilst the gastric end, doing double duty, becomes dilated and thickened. The partition elongating, and acting as a valve, turned towards the distal end, it tends to obstruct the intestinal passage of fæces; and thence the relative size of the two openings is still further exaggerated. Around the general aperture, the mucous membrane sometimes acquires an everted, protruding appearance, or an actual prolapsus of the membrane may take place; while the surrounding skin is puckered, and is irritated and excoriated by the feculent matter

FIG. 782.



escaping. The communication between the bowel and integument may not be *immediate*,—through the adhesive junction of the mucous membrane and skin; they may even be placed at some distance apart, a channel intervening between two apertures, internal and external. This modification of artificial anus occurs when the knuckle of intestine is lodged deeply; as in the neck of the sac, or within the abdominal cavity when an irrecoverable portion of intestine has been returned. In the latter case, fæcal matter begins to issue, a few days after operation, and gradually increases in quantity; until, from merely staining the dressing, the nature of the communication is plainly declared. The extent of intestine destroyed by the formation of artificial anus, varies to two and three inches or more; but the length of the portion of bowel involved has not interfered with complete recovery in some cases.

Treatment.—This will depend on the size of the aperture. A *small* opening—a fæcal fistula—may contract and close, by cleanliness and the pressure of a pad to restrain the discharge. This result may also be induced by the occasional introduction of a red-hot wire, or of the galvanic cautery. Closure can be directly effected sometimes by a plastic operation, as Velpeau proposed and practised; by engrafting a small piece of skin over the aperture, or by making an oval incision on either side and bringing the outer edges of the incisions together by means of fine needles and twisted suture.

A *large* aperture, and fairly *established* artificial anus, will very rarely contract and close, but requires a special surgical operation to effect a cure. The object is twofold; to destroy or diminish the spur-like partition, in order to regain the continuity of the intestinal canal, and then to close the external aperture. The destructive part of this proceeding may, perhaps, be accomplished by repressing the septum, according to Desault's method, by means of a tent thrust into both intestinal openings. It can be more surely accomplished, and with equal safety provided due caution be observed, by strangling the septum; for which purpose Dupuytren's *entérotôme* is admirably adapted. This instrument is simply a serrated forceps, worked by a screw across the end of its handle. (See Fig. 782.) The septum is grasped and compressed between the blades, and the pressure gradually increased by daily turning the screw, until the blades meet and the intervening septum has sloughed away in a week or ten days. Plastic lymph is thrown out simultaneously, whereby the peritoneum should remain unopened, when the instrument is withdrawn. Hence the caution necessary, not to grasp the septum too high up towards the mesentery, and to regulate the compression in concert with the plastic effusion. Some colicky pain or nausea may be induced, but no rigors or febrile disturbance. The continuity of the canal having been re-established, the margin of the external anal aperture must be pared and brought together by hare-lip sutures. But the constant discharge of fæcal matter tends to keep open the aperture; it was therefore proposed by Acrel to feed the patient by nutritive enemata, and life has been thus supported for a period of six weeks, during which the aperture contracted, and at length closed. The escape of pure bile occasionally produced pain and excoriation, but this was overcome by giving a spoonful of broth by the mouth from time to time. During the process of cure, I attach much importance to the influence of the recumbent position, which solicits the passage of any fæcal matter through the intestine, and thus favours contraction of the anal aperture. After an artificial anus has become entirely closed, the bowel remains permanently weakened, so that any fæcal obstruction, and, perhaps laborious occupation, may rupture the intestine, extravasation taking place and speedily fatal peritonitis. Death has thus occurred long after the patient might have been pronounced safe,—a caution to prognosis, and a hint for preventive treatment. The *results* of Dupuytren's operative procedure for artificial anus have been generally successful. Of forty-one cases in his hands, and in the practice of other Surgeons, twenty-nine, or say three-fourths, were completely cured in periods varying from two to six months; the remaining fourth, having been relieved of the involuntary escape of fæcal matter through the artificial opening, were so far restored from a sad condition, distressing to themselves and disgusting to others. It is encouraging to have to notice the slight mortality, compared with that of many other surgical operations; for only two patients died, or one in twenty who were submitted to treatment by the *entérotôme.*

A *permanent* artificial anus somtimes remains, having resisted all attempts at closure. This sad state may be made more tolerable by wearing a leathern receptacle or other contrivance; and it is gratifying to add that patients have thus been enabled to live in comfort and the enjoyment of good general health for many years. An artificial anus situated high up in connection with the intestine, and which discharges chyle or chyme, will of course constantly deprive the patient of nutriment; and this loss must be supplied by a proportionately increased quantity of nourishing food.

Double Hernia.—A protrusion on both sides of the body, symmetrically, in the same parts, or unsymmetrically, in different regions, not unfrequently occurs. More than two such herniæ are occasionally met with; and Sir A. Cooper records a case of six co-existing herniæ in the same person,—three on one side, an inguinal oblique, a direct, and a femoral hernia, with the same on the other side. In any such case symptoms of strangulation may be referable to this hernia or to that, and it is sometimes very difficult to determine which is the seat of strangulation. Hence, in double hernia, the operation may, perchance, be performed on that side where, when the sac is laid open, there is no appearance of strangulation in the hernial protrusion. What should then be done? The Surgeon is justified in operating on the other side, with the view of saving the life of his patient. An illustrative case of double operation in double inguinal hernia, and a successful result, happened in the practice of Dupuytren; and it may be referred to as a precedent under similar circumstances. The case is related in the "Leçons Orales," 1832, tome i. p. 583.

CHAPTER LVII.

SPECIAL HERNIÆ.

INGUINAL HERNIA.—*Structural Conditions.*—Inguinal hernia is that in which the visceral protrusion occupies part or the whole of the inguinal canal, presenting an *incomplete* hernia or *bubonocele;* or, passing through the external abdominal ring, it becomes a *complete* or *scrotal* hernia, sometimes named *oscheocele.* In the female, it passes into the labium. The hernia occurs in two principal varieties, as to its direction and relation to the deep (internal) epigastric artery; and which are designated, accordingly, the *oblique* or *external* inguinal hernia, and the *direct* or *internal* inguinal hernia. Thus, in point of direction, the hernia may take place through the internal abdominal ring and follow the oblique course of the spermatic cord in the inguinal canal, thence perhaps passing through the external ring and into the scrotum; or, the protrusion may come directly through the conjoined tendon of the internal oblique and transversalis muscles, into the canal, just behind the external abdominal ring, thence perhaps passing through that ring into the scrotum. With relation to the epigastric artery; in the oblique variety, the mouth of the sac is external; in the direct variety, it is internal to that vessel. Oblique inguinal hernia is named *congenital,* when the visceral protrusion lies within the tunica vaginalis, as its sac, in contact with the testicle; and *infantile* hernia, when the protrusion, carrying before it a peritoneal sac, lies just behind and dips into the tunica vaginalis as an independent sac—constituting what is also termed *encysted* hernia.

There are, then, three varieties of inguinal hernia: oblique or external; direct or internal; congenital, and its sub-variety, infantile or encysted.

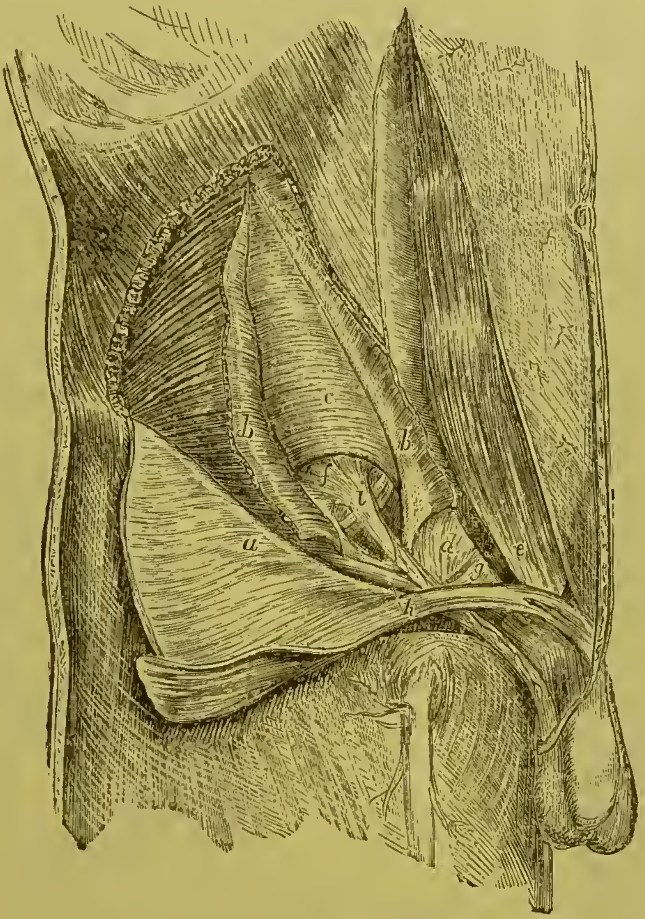
OBLIQUE INGUINAL HERNIA.—*Course.*—This is the most common form of inguinal hernia. Its course is the same as that of the testicle in its passage from the internal abdominal ring through the inguinal canal and external ring into the scrotum; this route corresponding also to the spermatic cord in the same extent of its course.

Anatomical Coverings, and Relations.—The *coverings* of oblique inguinal hernia consist of those layers of different textures which successively invest the protrusion, in its formation and progress. They are the same investments that the spermatic cord receives,—seven in number, and they may be conveniently enumerated from within, outwards, in the order of hernial development, as follow: peritoneal pouch forming the sac of the hernia, its sub-serous cellular tissue, and the fascia transversalis abdominis or infundibuliform fascia (Fig. 783); cremasteric fascia, consisting of looped fibres of cremaster muscle proceeding from the internal oblique, with interstitial cellular texture; intercolumnar or spermatic fascia, consisting of tendinous semicircular fibres passing across between the pillars of the external abdominal ring, and thence prolonged downwards from the upper margin of the ring; superficial fascia, containing fat; and skin. These anatomical coverings are interesting with reference to the development of oblique inguinal hernia; but they become so altered in appearance and united by pressure, as to have much less importance surgically.

The relations of the inguinal canal, spermatic cord and testicle, to the visceral protrusion, and of the deep epigastric artery to the mouth of the sac, are specially important.

The *inguinal canal* is the interval between the abdominal parietes, just above the inner half of Poupart's ligament; it extends obliquely downwards and inwards, about one inch and a half in length, from the internal abdominal ring to the external abdominal ring at the crest of the pubes. Its boundaries, and thence the relations of inguinal hernia in the canal, are thus formed:—anteriorly, by the aponeurosis of the external oblique muscle, and beneath by the arched fibres of the internal oblique, over the outer half-inch of the canal, and the aponeurosis of the external oblique alone, the inner inch; posteriorly, by the fascia transversalis and the conjoined tendon of the internal oblique and transversalis muscles, the fascia extending along the outer half-inch of the canal, corresponding to the internal oblique, and the conjoined tendon, with the fascia transversalis behind it, along the inner inch, corresponding to the aponeurosis of the external oblique. Inferiorly, the floor of the canal is formed by the junction of the fascia

FIG. 783.*



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* *a*, external oblique muscle reflected; *b b*, internal oblique, arching over and covering the internal abdominal ring; *c*, transversalis muscle; *d*, conjoined tendon; *e*, rectus muscle, sheath opened; *f*, fascia transversalis; *g*, triangular aponeurosis of conjoined tendon; *h*, cremaster; *i*, infundibuliform fascia. (John Wood.)

transversalis with Poupart's ligament; and superiorly, it is limited only by the apposition of the muscles.

The *cord* lies behind or underneath the hernia, the *testis* below and somewhat behind its lowest part—the fundus, and these two are always distinctly separate. (Fig. 784.) Occasionally, the elements of the cord are dispersed by the hernial descent; the vas deferens lying on one side and the spermatic vessels on the other; and rarely, the cord lies partially or entirely in front of the hernia, the testicle also below being in front. In the latter case sometimes, the elements of the cord are spread out in front of the hernia. The *epigastric artery*, arising from the external iliac about a quarter of an inch above Poupart's ligament, bends inwards and ascends beneath the fascia transversalis, immediately behind and *internal* to the mouth of the sac—at the internal abdominal ring, which is thus placed external. (Fig. 785.) The course of this artery varies, however, with the duration of the hernia, and occasionally owing to an abnormal origin of the vessel. In old-standing hernia, the dragging pressure of the tumour downwards and inwards, curves the artery in that direction towards the outer edge of the rectus muscle; until it may thus be brought internal to the situation of a direct hernia. (Fig. 786.) An *abnormal origin* of the

Fig. 784.*

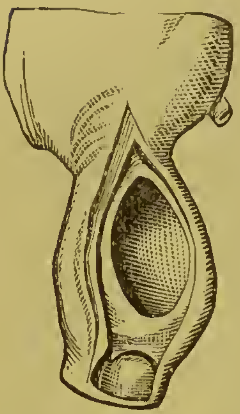


Fig. 785.†

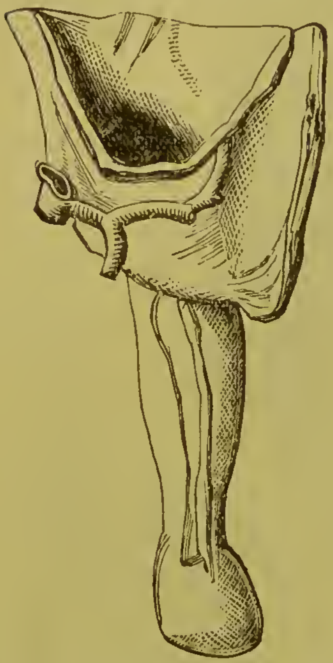
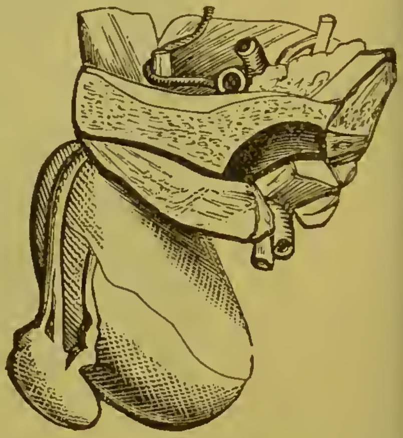


Fig. 786.‡



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* St. Thomas's Hosp. Mus., R. 29. Sac of oblique inguinal hernia; showing testis at lower end, separate from the sac, and projecting into the cavity of a small tunica vaginalis.

† Ibid., R. 35. Oblique inguinal hernia; showing epigastric artery below, and then on the inner side of the neck of the sac. The obdurator artery is given off about a third of an inch from the origin of the epigastric, and passes downwards on the outer side of the neck of the sac. The tunica vaginalis is laid open in front.

‡ Roy. Coll. Surg. Mus., 1322. Oblique inguinal hernia, on the right side; showing displacement inwards of the neck of the sac, drawing with it the epigastric artery, so far that the vessel reaches the lower part of the rectus muscle before it turns upwards. The neck of the sac being opposite the external abdominal ring, the straight direction of the hernia in the inguinal canal appears as if it were a direct inguinal hernia. The vas deferens and spermatic vessels, lying on the inner and posterior part of the sac, are widely separated from each other. (Howship.)

artery occurs comparatively rarely; its position may be shifted upwards on the trunk of the external iliac, from the level of Poupart's ligament, as high as two inches and a half above it; or the vessel may arise from another source,—the obturator; or from below the ligament, being transferred to the superficial or the deep femoral artery.

Of these abnormal sources of the epigastric artery, the first has no relation to the internal abdominal ring; the two latter may have special relation to the crural ring, and therefore to femoral hernia.

Seat of Stricture.—Commonly, the stricture is situated at the mouth of the sac, in the internal abdominal ring; next in order of frequency at the border of the internal oblique muscle, in the inguinal canal; lastly, at the external abdominal ring.

DIRECT INGUINAL HERNIA.—*Course.*—This variety of inguinal hernia comes forward through a small triangular space, bounded by the epigastric artery *externally*, the margin of the rectus muscle on the inner side, and Poupart's ligament—its inner portion—below. (Fig. 787.) This space is situated just behind the external abdominal ring, the conjoined tendon and fascia transversalis intervening.

FIG. 787.*

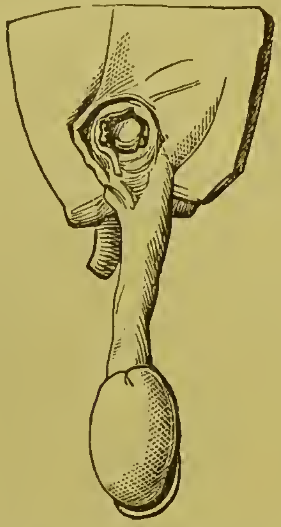
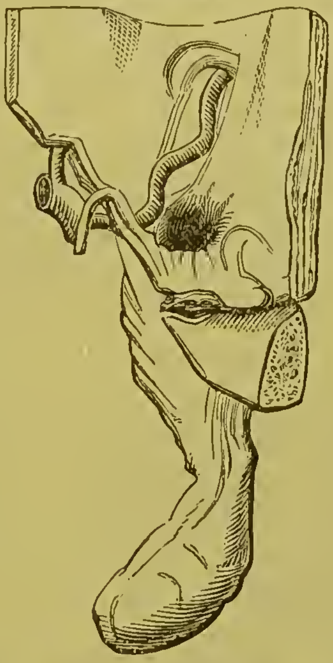


FIG. 788.†



Anatomical Coverings, and Relations.—In number the coverings are the same as those of the oblique variety, and in kind they are the same, with one exception; the conjoined tendon is substituted for the cremasteric fascia. Thus, enumerating them in the order of hernial development, the coverings of direct inguinal hernia are—peritoneal pouch or sac, sub-serous cellular tissue, fascia transversalis, conjoined tendon, sometimes ruptured, intercolumnar fascia, superficial fascia, skin. The *spermatic cord* lies on the outer side of the sac, the testicle below the fundus, and both are distinctly separate; the epigastric artery also courses up *external* to the mouth of the sac, curving over it inwards, so as sometimes to embrace the upper as well as the outer margin. (Fig. 788.)

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* St. Thomas's Hosp. Mus., R. 62. Direct inguinal hernia, which has not yet descended through the external abdominal ring; the hernia thus being incomplete, or a bubonocele. The cord lies on the outer side of the sac.

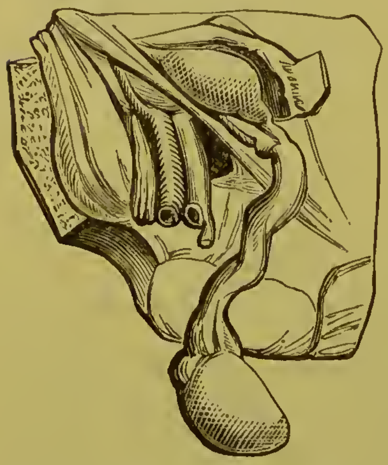
† Ibid., R. 59. Direct inguinal hernia; showing the epigastric artery passing upwards and inwards on the outer side of the neck of the sac, between it and the internal ring.

Seat of Stricture.—Commonly, the stricture is situated at the mouth of the sac; next in frequency at the conjoined tendon, when ruptured; lastly, at the external abdominal ring.

In the *female*, the anatomy of Inguinal hernia, oblique and direct, is essentially the same as in the male; except that the round ligament in the inguinal canal takes the place of the spermatic cord, and the labium pudendi that of the scrotum. Females are liable to both forms of inguinal hernia, the oblique occurring at very early periods of life. Excepting umbilical hernia, *oblique* inguinal is the only kind developed before five years of age; and, until the age of puberty, it is more common than any other variety of hernia. This form is not much more rarely met with than femoral, as generally supposed. Thus, in 1582 females affected with hernia, in one form or the other, who came under Mr. Kingdon's observation, 761 had inguinal hernia, and 812 femoral hernia. Or, the one was only thirty less than half the total number, whilst the other was only thirty more than half that number. But *direct* inguinal hernia is certainly very uncommon in females at any age. Sir A. Cooper never met with a single case in the course of his practice; and Lawrence saw only one instance of this form of hernia in a female subject for dissection.

Signs of ordinary Inguinal Hernia.—The *oblique* variety commences as a slight fulness or swelling at the internal abdominal ring, just above the centre of Poupart's ligament; next, passing downwards and inwards in the inguinal canal, it presents an oblong tumour having that direction, in this situation—an incomplete inguinal hernia, or *bubonocele*. (Fig. 789.) Still further protruding through the external abdominal ring and descending into the scrotum, or the labium in the female, the tumour enlarges into a globular form,—as a complete, or *scrotal* hernia. It may attain to an enormous size, extending down even to the knee, as in cases to which I have already referred; although a far smaller size in women, unless in quite exceptionally rare cases, where the hernial tumour has extended two-thirds down the thigh. But—in males—the testicle can always be felt distinct, at the bottom and back part of the fundus. The usual symptoms of hernia are perceptible; enlargement and impulse on coughing in the erect attitude, diminution and disappearance of the tumour when compressed, in the recumbent position. These symptoms will, however, be more or less perceptible, according to the size of the hernial protusion; being less so when it occupies the inguinal canal, as *bubonocele*, and most conspicuous in *scrotal* hernia. In old-standing oblique hernia, the neck of the sac is dragged downwards and inwards towards the

Fig. 789.*



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* Roy. Coll. Surg. Mus., 1316. Incomplete oblique inquinal hernia, on the left side, in the male. The tendon of the external oblique and the lower margins of the internal oblique and transversalis muscles having been raised, the hernial sac is seen in the upper half of the inguinal canal. The external ring is left entire. The obturator artery is given off by a short common trunk with the epigastric. (Howship.)

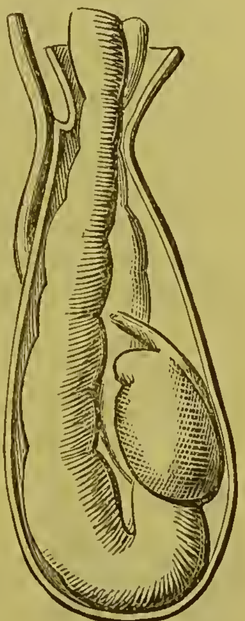
middle line; so that the distinctive shape of the inguinal portion is lost, and the tumour comes to resemble the next form of inguinal hernia.

Direct Inguinal hernia presents a tumour which differs in situation, and somewhat in shape and size, from that of the oblique hernia. This direct variety is situated at the external abdominal ring, near the root of the penis, the outer portion of the inguinal canal remaining unoccupied; the tumour is more globular, not pyriform as in the oblique, and it has a wider neck; usually, it is not so large. The other symptoms are similar; but, when strangulation occurs, I have noticed that the pain caused by even moderate taxis is greater than in the oblique form of hernia; and as arising, apparently, from pressure of the tumour on the spermatic cord in the unyielding angle between the pubic crest and the external pillar of the abdominal ring.

The proportionate frequency of the two forms of inguinal hernia may be remembered in connection with their diagnosis. Direct inguinal hernia is met with far less frequently; Cloquet estimating the proportion at one to five oblique herniæ, or twenty per cent.; or in only ten per cent., according to Hesselbach's computation.

Both varieties of inguinal hernia may coexist in the same individual; or double inguinal hernia, one on either side, is occasionally met with. Not unfrequently, the hernia on one side is incomplete—a bubonocele; and on the opposite side, an ordinary complete inguinal hernia—a scrotal hernia. In one case, a double inguinal hernia occurred on the same side, forming an anterior and a posterior sac; the spermatic cord lying behind the latter and the lower portion of the anterior sac. (See Fig. 772.)

Fig. 790.*



Congenital Hernia.—This variety of oblique inguinal hernia was first noticed by Haller in 1749, and its nature was more particularly described by John Hunter and Percival Pott. The peculiar structural condition is this: the visceral protrusion lies in the tunica vaginalis, with, and in contact with, the testicle, when that organ has previously descended from the abdomen into the scrotum.

The course, coverings, and relations of the hernia are the same as those of the ordinary oblique, except that the *sac* is the tunica vaginalis, and the relation of the *testis* is immediate, it being within the sac, although the situation of that body, as lying below and somewhat behind the hernial contents—not the fundus of the sac—remains unaltered. But it is possible for the hernia to descend even below the testis, leaving that body behind it. (Fig. 790.) The visceral protrusion passes down from the abdomen, through the vaginal process of peritoneum which connects the peritoneal cavity with the tunica vaginalis; this process having remained unobliterated after birth, instead of closing as usual in about three weeks or a month. Paletta states that, normally, the complete closure of the vaginal canal takes place from the twentieth to the thirtieth day after birth. But when the canal remains pervious, although the tendency to this hernia thus dates from

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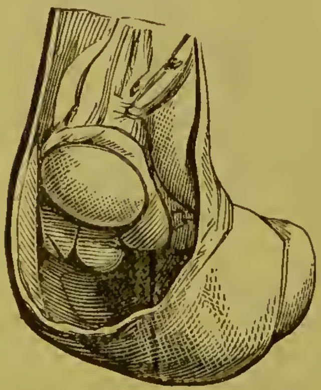
[*] St. Thomas's Hosp. Mus., R. 23.

birth, it may not occur for years afterwards. Hence the hernia itself is not, properly speaking, congenital, and it might be more correctly designated, as Mr. Birkett has suggested, "hernia into the vaginal process of the peritoneum." Occurring, therefore, in early life—in infants a few weeks or months old—this species of hernia also occurs, for the first time, at perhaps any subsequent period of life. Cases between the ages of eighteen and twenty-five are recorded by Velpeau; and I once operated on a right congenital hernia in a middle-aged man in whom, after death, I found the left vaginal process completely pervious, admitting a large-sized elastic catheter from the internal abdominal ring to the testicle. Thus, this was a case in the adult of strangulated congenital hernia on one side, and the persistent structural condition without hernia on the other side. The preparation is in the Museum of the Hospital.

The relation of the *testicle* to congenital hernia is very important; associated with congenital persistence of the vaginal process of peritoneum, the testis on the same side frequently occupies an abnormal situation. There will then be two persistent congenital conditions, both arrests of development; the one, an unobliterated state of the vaginal process of peritoneum, which should be temporarily provided only as a sheath for the descent of the testicle into the scrotum; the other, an arrested descent of the testicle. Congenital hernia may, therefore, not as usual contain the testicle in the tunica vaginalis or hernial sac, the testis never having descended into the scrotum.

The *abnormal conditions of the vaginal process* of peritoneum, in connection with the *abnormal situations* of the *testicle*, and the relative positions of the *hernia* to this organ, may be thus tabulated (Birkett):

FIG. 791.*



(1.) The vaginal process continuing open and common to the cord and testis.

The testis may be situated—

a. in its normal site at the fundus of the scrotum;

b. just outside the external abdominal ring, or between its pillars (Fig. 791);

c. within the inguinal canal;

d. within the abdomen.

N.B. In *a*, *b*, *c*, the hernia is generally in contact with the testis; in *d*, it is not.

(2.) The vaginal process of the cord and testis communicating by an intermediate aperture.

The testis is in the scrotum.

N.B. The hernia may or may not pass through this aperture, and is therefore sometimes but not always in contact with the testis.

(3.) The vaginal process of the cord only being open—Hernia into the funicular portion of the vaginal process. This condition was first described by M. Malgaigne.

The testis is in the scrotum.

N.B. The hernia is never in contact with the testis.

Additional sacs, or prolongations and extensions of the vaginal process, sometimes exist within the abdominal walls;—"intra-parietal,"

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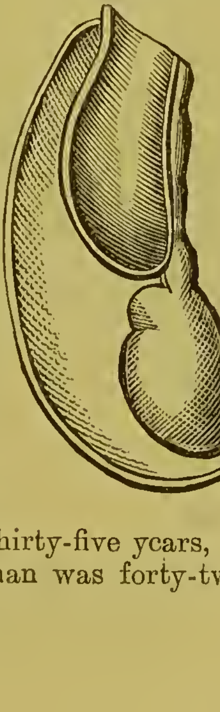
* Roy. Coll. Surg. Mus., 1342. The sac of a congenital hernia, with the testicle situated at the external abdominal ring. (Sir W. Blizard.)

"inter-muscular," "interstitial, hernial sacs," "hernie-enbissac" of French authors. Coincident with misplaced testis there may, therefore, be an abnormal disposition of the hernial sac, itself abnormal. An offset from the vaginal process of peritoneum, forming a second sac, may extend into the substance of the abdominal wall. The hernial sac will then consist of two parts: that division which passes along the inguinal canal into the scrotum, and that which is lodged in the wall of the abdomen. This extra sac extends in one of two directions: into the anterior, or into the inferior, wall of the abdomen. In the one direction, the sac passes upwards from the inguinal canal between the internal abdominal fascia and the aponeurosis of the external oblique muscle; coursing directly upwards, outwards towards the crest of the ilium, or inwards towards the rectus muscle and umbilicus. Very rarely, the sac comes forward through the external abdominal ring and cannot enter the scrotum; it ascends between the aponeurosis of the external oblique and the integument, and when the hernia protrudes, it forms a tumour in the groin above and parallel with Poupart's ligament. An example of this variety is quoted by Scarpa, and another instance is recorded by Dr. Fano in "L'Union Médicale," 1861. In the other direction, the sac passes downwards, between the internal abdominal fascia and peritoneum, into the iliac fossa, and rests upon the iliacus muscle; or inwards, behind the horizontal ramus of the pubes, reaching the side and front of the urinary bladder. Cases are given by Dr. Parise in the "Mém. de la Soc. de Chirurgie de Paris," 1851.

Infantile or Encysted Hernia.—This variety of congenital hernia was first described by the late Mr. Hey, of Leeds, in a letter to Dr. Gooch. It coexists with another abnormal condition of the vaginal process of peritoneum. The abdominal orifice is closed, but the sheath persists from that point downwards to the testis, and there expands into the tunica vaginalis, as in ordinary complete congenital hernia. The visceral protrusion carries before it a pouch of the parietal peritoneum of the abdomen, into or just behind this sheath; and, as Mr. Hey described it, the tunica vaginalis is continued up to the abdominal ring, and encloses the hernial sac. Thus also, as Lawrence observes, the protruded part, together with the sac, are contained in the tunica vaginalis. In this manner the hernia is encysted; and a double sac is discovered in operating on such a hernia, the tunica vaginalis sac lying in front of the true hernial sac. (Fig. 792.) Compared with the more frequent occurrence of congenital hernia, the encysted variety is rare. But, like the former, it does not necessarily arise at the earliest period of life; so that the term Infantile is inappropriate. Hey's case was an infant fifteen months old; and the hernia has since been met with, for the first time, at the age of twelve years, in a case reported by Mr. Holmes; at seventeen years of age; and at thirty-five years, in a case on which Mr. Birkett operated when the man was forty-two years old.

FIG. 792.*



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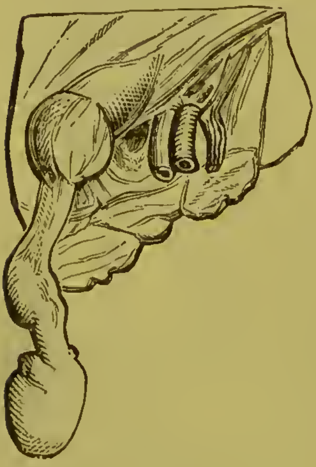
* St. Thomas's Hosp. Mus., R. 24.

Signs and Diagnosis of Congenital, and of Encysted Hernia.—The *congenital* variety presents no peculiar characters whereby it can be distinguished from the ordinary oblique inguinal hernia, excepting with regard to the relation of the testicle to the hernial tumour.

In *scrotal* congenital hernia, the testis cannot be felt separate and distinct; although the situation of that body below and somewhat behind the hernial contents—not the fundus of the sac—remains unaltered, in this the ordinary complete congenital hernia. The scrotal tumour is rounder, and the neck more narrow and contracted. The latter sign is more marked when the hernia has not descended for some time after birth, as the vaginal process of peritoneum will then have become condensed, feeling like a somewhat enlarged and indurated spermatic cord. In the adult, this long narrow neck is specially characteristic of scrotal congenital hernia. But the more defined scrotal swelling may be mistaken for hydrocele.

In congenital hernia, scrotal or inguinal, with *undescended* testicle, the absence of this organ from its normal situation will declare the nature of the hernia. The testis may be found just outside the external abdominal ring or between its pillars; within the inguinal canal; or within the abdomen. Still, in the first two modifications of congenital hernia, the hernia is generally in contact with the testis; in the last named it is not so. An *inflamed* undescended testicle simulates the symptoms of strangulated hernia; thus obscuring the diagnosis of these two conditions,—orchitis and congenital hernia presumably strangulated. In the inguinal canal, the tumour, having an oblong shape, may be tense and painful, with some abdominal tenderness emanating from that situation, and there may be perhaps nausea and constipation. But if it be the orchitis of a misplaced testicle, these symptoms subside after a while, and especially the constitutional disturbance; leaving only a tumour of diminished size, the testicle, in the inguinal canal. And the absence of this organ from the scrotum will have suggested, in the first instance, the probable nature of the case. In any case of supposed congenital or infantile hernia, the duration of the tumour from childhood, in some instances, will throw some light on the question of diagnosis.

Fig. 793.*



Encysted hernia presents no distinctive characters from congenital hernia; but the testicle can be felt distinct from the hernial contents, at the bottom of the scrotum. The precise nature of the hernial tumour is, however, usually discovered only during an operation, when requisite for the relief of strangulation.

Diagnosis of Inguinal Hernia.—Every inguinal hernia escapes from the abdomen above Poupart's ligament.

Femoral hernia is distinguished as follows. When inguinal hernia is confined to the inguinal canal—as an incomplete hernia or *bubonocele*—Poupart's ligament can always be traced along its inferior border, and the hernial aperture is situated above this ligament. (Fig. 793.) In this way the tumour is distinguished from femoral hernia, which is situated below the ligament, and this band can always be traced along the superior border of the tumour. When the hernia has become *scrotal*, it will have escaped through the external abdominal ring, the outer pillar of which is attached to the spinous process of the pubes. Placing the point of the finger on this process, if the neck of the tumour lies internally—between the finger and the symphysis pubis, the protrusion must have passed through the external abdominal ring, a demonstration of its being of inguinal origin. A hernial tumour situated to the outer side of the finger, will probably have passed through the crural ring, and thence be a femoral hernia. But, in rare cases, complete inguinal hernia is not scrotal; the protrusion, having passed from the inguinal canal, through the external ring, descends downwards and turns outwards into the bend of the thigh—appearing, in situation, as if a femoral hernia. This may be owing to a deficiency in the external pillar of the ring, or of the anterior wall of the canal, whereby the inguinal protrusion may more nearly resemble a femoral hernia. But the neck of the tumour, at the hernial aperture or internal ring, is still always above Poupart's ligament.

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* Roy. Coll. Surg. Mus., 1319. (Howship.)

Chronic tumours in the inguinal region and scrotum respectively, may, with regard to their diagnosis from inguino-scrotal hernia, be divided into two classes—reducible and irreducible tumours.

Reducible tumours comprise—(1) inguinal hernia—also congenital, and infantile or encysted; (2) hydrocele of the vaginal process of the peritoneum; (3) hydrocele of the funicular portion of the same process; (4) varicocele of the spermatic veins; (5) abscess descending through the inguinal canal.

Irreducible tumours may be either fluid or solid, or mixed solid and fluid. The fluid are—(1) hydrocele of the tunica vaginalis testis; (2) hæmatocele in the same sac when first developed; (3) encysted hydrocele of the epididymis; (4) hydrocele of the spermatic cord. The solid, or solid and fluid, are—(1) diseases of the testis (*a*) of inflammatory origin, (*b*) specific new growths; (2) undescended testis in inguinal canal—also inflamed; (3) old hæmatocele; (4) diseases of the spermatic cord; (5) growths of fat extending from the inguinal canal into the scrotum ; (6) diseases of the tissues of the scrotum. All these diseases, presenting swellings or tumours, are described in other parts of this work; it will here suffice to notice their points of difference from inguino-scrotal hernia, which may be conveniently exhibited in a tabular form, taken—with one or two additions—from Mr. Birkett's treatise.

Some of these diseases are, however, of less frequent and even rare occurrence. The Surgeon will mostly have to distinguish between inguino-scrotal hernia and hydrocele—in its various forms, or hæmatocele; orchitis, and perhaps tumours of the testicle, as compared with scrotal hernia, may also become a question of diagnosis.

THE REDUCIBLE TUMOURS.	*Their Entrance or Return into the Abdomen.*		*Their Passage from the Abdomen.*
	Characters in common.	*Special Characters, when uncomplicated.*	*Special Characters.*
1. Inguinal Hernia.	*All* return into the abdomen most easily when the patient lies recumbent, and the abdominal muscles are relaxed.	1. *Hernia* enters most readily. When once commenced, passes in quickly and suddenly. Entrance complete. Thick and opaque neck of tumour. Testis may or may not be perceptible until reduced. *No* vibration.	1. Is developed from above, descends when the patient rises or exerts the abdominal muscles, and more quickly than others. Pressure over the ring prevents its descent.
2. Hydrocele of vaginal Process of Peritoneum.	———	2. *Hydrocele* of vaginal process of peritoneum enters slowly, and never suddenly. Entrance complete. Narrow and translucent neck of tumour. Testis imperceptible until the fluid has entered the abdomen. Vibration.	2. Seems to be developed from below upwards. The serous fluid sometimes remains when patient is recumbent.
3. Hydrocele of funicular portion of vaginal Process of Peritoneum.	—	3. *Hydrocele* of funicular portion of vaginal process enters like No. 2. Entrance complete. Translucent Neck of tumour may pass into inguinal canal. Testis perceptible at fundus of tumour. Vibration.	3. Similar to No. 2.
4. Varicocele.	—	4. Varicocele enters very slowly. Entrance not complete, the bulk of tumour only diminished. *No* vibration.	4. The tumour increases like hernia when the patient rises; but it increases also if pressure be made over the course of the spermatic veins in the inguinal canal, or by retardation of the blood, however caused.
5. Abscess.		5. Reducible.	5. Fluctuation, and special history.

THE IRREDUCIBLE TUMOURS.

Disease.	*Weight.*	*Translucency.*	*Fluctuation and Vibration.*	*Relation of Testis to Tumour.*	*Figure and Development.*	*Size.*	*Consistence.*	*Pain.*
Hernia.	Lighter than either the fluid or solid tumours.	Very rarely so; generally opaque.	Only when fluid coexists with the hernia.	Position variable, but the testis usually discoverable.	Pyriform, but with thick neck. Occasionally globular or ovoid. Outline regular. Begins at neck of scrotum and descends.	Variable; at times very large.	Soft and yielding, except it be omental.	Painless, unless diseased.
Fluid Tumours.	Hæmatocele rather heavier than hydrocele.	Hydrocele particularly so. In rare cases opaque. Hæmatocele opaque.	Distinct vibration very characteristic, as in hydrocele.	Perceptible in spermatocele; not in hydrocele of tunica vaginalis propria testis, usually.	Pyriform, but with very thin neck. Outline very regular. Globular as hydrocele of spermatic cord. Oblong as in spermatocele, and nearly transverse to vertical axis of scrotum. Begin near fundus of scrotum and ascend.	Rarely very large.	Yielding and elastic. Exceedingly incompressible as hydrocele of cord.	Painless, unless testis be squeezed, usually.
Solid Tumours.	Generally heavier than fluid.	Opaque.	Absent.	Often involved and imperceptible, though its site may be discoverable by pressure. Undescended testis in inguinal canal—its absence from scrotum, and the differential characters of other inguinal tumours.	Outline of testis often preserved. Sometimes surface irregular.	Large; steadily increasing.	Resisting, firm, and rarely hard.	Painful, but varying in degree.
Mixed Tumours.	Heavy.	Sometimes in parts of them.	In some parts, not in others.	Involved.	Irregular outline.	Large; at times rapidly increasing.	Resisting in parts, soft in others.	Variable.

The *coexistence* of inguinal or inguino-scrotal tumours or swellings, when it occurs, will always complicate the diagnosis. Thus, Scrotal hernia may be complicated by the coexistence of hydrocele. Yet the two swellings retain their distinctive characters;—the hernial portion having an impulse on coughing and being reducible; and usually defined from the hydrocele by a constriction or boundary, more or less perceptible to the touch when handled, and even to the eye when the patient stands up. The hydrocele is, commonly, anterior.

Treatment.—Inguinal hernia, in common with other herniæ, requires different treatment according to whether it be reducible, irreducible, or strangulated; besides which there is the special adaptation of treatment to the special varieties known as congenital and encysted herniæ.

Reducible hernia should be returned, as soon as possible, by employment of the taxis; care being taken that this manipulation of the tumour be conducted gently, in the manner already fully described. The direction of pressure is particularly important; and the terms oblique and direct, with regard to inguinal hernia, will sufficiently suggest the course of the hernial protrusion. But, in old oblique herniæ, the canal will have become nearly direct, from the constant dragging in and dilatation of the internal or deep ring. In children also, the canal is very direct, the two rings lying nearly opposite each other. When reduced, a suitable and well-fitting truss must be applied and worn. The pad must be so adjusted as to fairly close the hernial aperture; in the oblique inguinal, it should press not only upon the external abdominal ring, but also upon the whole length of the anterior wall of the inguinal canal; in the direct inguinal, the external ring only need be closed. Some pain or discomfort, owing to pressure on the spermatic cord, may require a little readjustment of the truss.

Fig. 794.

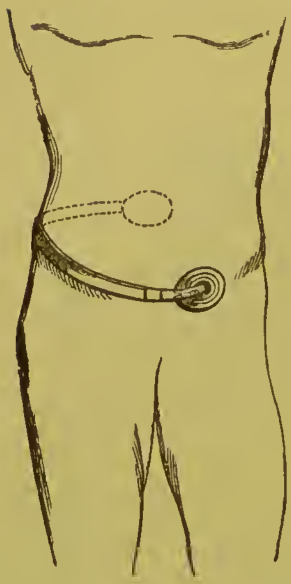
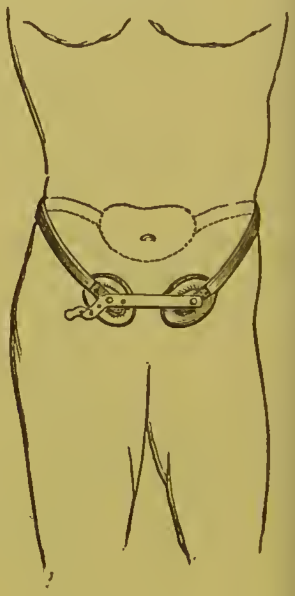


Fig. 795.



Inguinal Hernia Trusses.—Various forms of Truss have been invented, and used for Inguinal hernia. These which are more commonly employed differ in their construction, and relative advantages, as follow:—(1.) Salmon and Ody's truss. Its peculiarities are—(*a*) the spring extends from the centre of the spine across the abdomen to the abdominal ring; the truss being so formed that it passes round the opposite half of the body to that on which the hernia descends. (*b*) The pad is attached to a ball-and-socket joint, so that it may more accurately follow the movements of the trunk. (Fig. 794 represents the *single* truss of this description; Fig. 795, the *double* truss, or that for double inguinal hernia.) Salmon and Ody's truss is a most efficient form of support; I have used it successfully where other inguinal trusses have failed; its special advantage being the *immovable* pad. (2.) Cole's truss differs little from the preceding, in the spring; but it is applied to the side of the body on which the hernia occurs. The speciality of construction, as patented, is, however, in the pad; it is pear-shaped, and contains within it a flat helical spring, which acts as the ball-and-socket joint, but retains the pad more accurately fixed against the internal abdominal ring. (Fig. 796.) The strap around the waist, as here depicted, is an exceptional appendage; it having been added, by Mr. Bigg, for a patient with an abscess just above the hip-joint, where the slightest touch could not be borne on the part subject to the pressure of an ordinary Cole's truss. This also is a most efficient truss, especially perhaps for inguinal hernia of *larger* size, where the abdominal rings are more open; but—allowing the more favourable shape of the pad for this special purpose—the action of the helical spring tends to bury the pad, and thus dilate the internal abdominal ring,—the aperture of protrusion; and I do not find the pad so freely movable in accordance with the ever-varying movements of the trunk, in walking or riding on horseback. (3.) Tod's truss has two peculiarities of construction: a spring which passes *over* the crest of the ilium, and not below it across the buttock—thereby apparently exercising a more direct control over the internal ring; and a diminished size of the pad. The former supposed advantage is, I think, sufficiently provided for by the ball-and-socket joint over the pad, without the specially oblique position of the spring; and the latter peculiarity, a smaller-sized pad, is a positive disadvantage, by tending to bury itself and thus enlarge the internal ring. (4.) The *Moc-Main* truss is a *lever*-truss, and Bigg's *triple lever*-truss, another of the same kind of instrument; inguinal lever-trusses. The former consists of a padded leather pelvic band and a large oval pad. But the pad is stuffed with floss silk, in the midst of which a small metal lever is placed. A thigh-strap is attached by one extremity to this lever, and controls its action when the truss is in use. The advantage of this instrument is its flexibility, whereby

FIG. 796.

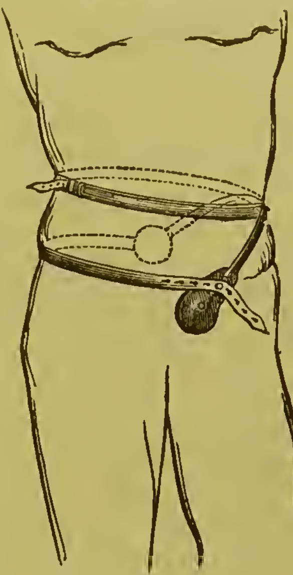
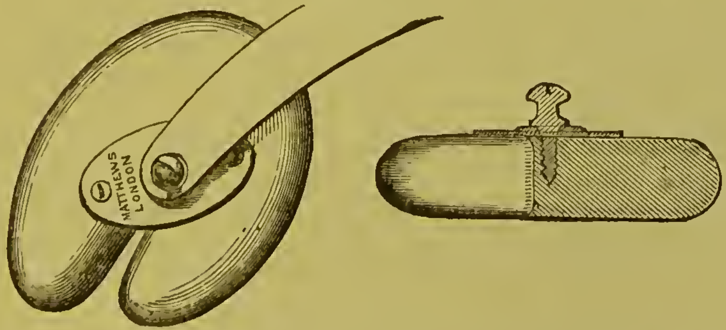


FIG. 797.



it can be worn when necessary to control a hernia in the night as well as in the day; but, as the sitting posture loosens the spring by diminishing the tension of the under-strap, the support of this truss is insecure except during perfect rest. Bigg's *triple* lever-truss brings three lines of force to bear on the hernial ring; it is thus specially fitted for exceptional cases of inguinal hernia, which cannot be controlled or supported by previously described trusses.

FIG. 798.

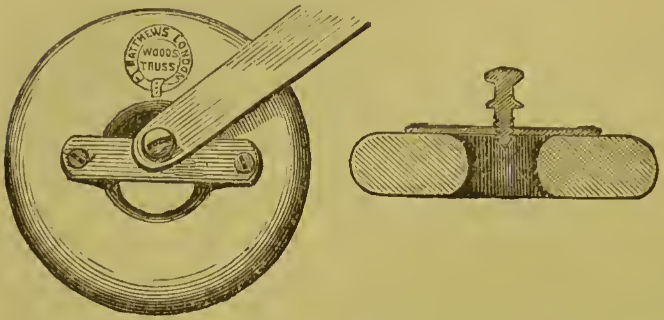
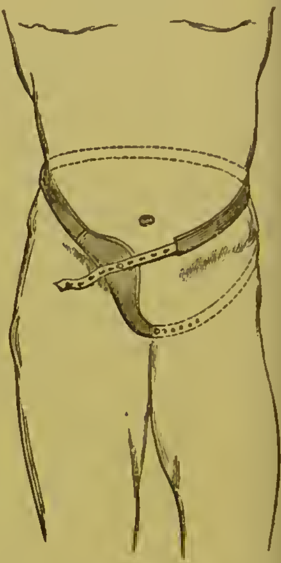


FIG. 799.



The *horse-shoe* pad, devised by Mr. John Wood (Fig. 797), affords a very efficient support for oblique inguinal hernia; and the *ring*-pad (Fig. 798) is well adapted for the direct form of hernia. Both the trusses, thus fitted, are made by Messrs. Matthews.

Scrotal hernia Truss has two peculiarities of construction. It is formed of a padded pelvic spring, as in other trusses, but the pad, instead of being pear-shaped or oval, is *fusiform;* and the lower prolongation is attached to a *perineal* strap. (Fig. 799.) This strap being carried round the posterior part of the thigh opposite to the rupture, and fastened to the pelvic spring, keeps the pad firmly fixed along the whole length of the inguinal canal; and guards also the external aperture. Thus, then, both the inguinal protrusion, and its continuation as scrotal hernia, are prevented.

On looking at the various forms of Truss above described, it will be seen that they differ somewhat in the *pelvic spring* having a transverse or oblique direction; but the principal peculiarity of each consists in the *pad*—as to its shape, oval, pyriform, fusiform, horseshoe, or ring; its immobility, by a ball-and-socket joint or helical spring; and its further adaptation by padding. In regard to this last particular, other pad-materials may also be mentioned—the *sand*-pad, and the inflated-pad, with *air* or *water*.

Strangulated Hernia.—The operation for liberating inguinal hernia, at the seat of stricture, and then returning the visceral protrusion, is conducted in accordance with the procedure already fully described in the general treatment of Hernia. It will therefore be requisite to notice only those particulars which are peculiar to the inguinal operation.

This operative procedure may be described as follows:—The patient lying on his back, and under the influence of chloroform, and the parts having been shaved, an incision is made in the course of the neck of the tumour, by pinching up the skin transversely about opposite the external abdominal ring, and transfixing the fold. (Fig. 800.) Any small bleeding arterial vessel had better be secured by a pinch or twist with the forceps, so as not to obscure the dissection. Then, cautiously dividing the superficial fascia and other coverings, by using the scalpel with a lateral, scraping action, or even more cautiously, by dividing the textures successively on a director, the sac is soon reached below the external ring, or above that point,—on thus dividing the tendinous aponeurosis of the external oblique. Rarely, the cord lies in front of the sac; if so, it must be drawn to one side, out of the way. The sac is recognized by its appearance: thin and translucent, and transmitting the colour of its hernial contents, in recent hernia; thick and opaque white, in old hernia.

The seat of stricture is then sought for, as it may be found perhaps external to the sac; either at the external abdominal ring, the border of the internal oblique muscle, or, most frequently, at the internal abdominal ring,—in oblique hernia; or at the external ring, the margin of the conjoined tendon when ruptured, or, most frequently, at the mouth of the sac,—in direct hernia. If situated at either of the more superficial points, with regard to either form of hernia, the stricture can be divided *external* to the sac; and then sometimes the hernia becomes reducible. Otherwise, the seat of stricture being *internal*, as it usually is, or if the symptoms of strangulation have been persistent, the sac must be opened, and in the ordinary manner. By carefully nipping up a small portion with the forceps, and using the knife flatwise, a small button-hole incision is made; this aperture is then enlarged by slitting the sac upwards and downwards, cautiously, on a broad hernia-director, and with a probe-pointed bistoury. If the director be elevated so as to stretch the sac over it, there will be scarcely any risk of wounding the bowel, which might otherwise overlap the instrument. But I generally use my finger as a director, in this and other operations for hernia.

Fig. 800.

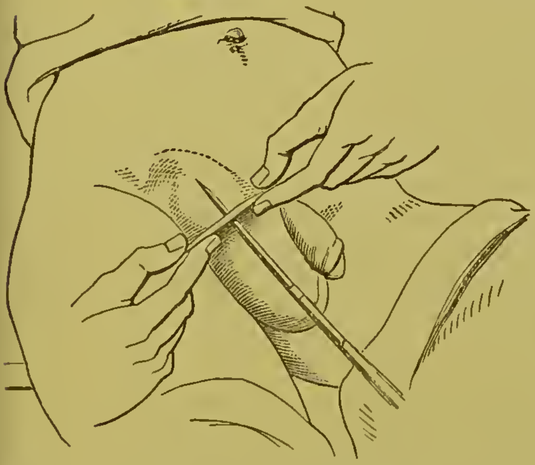
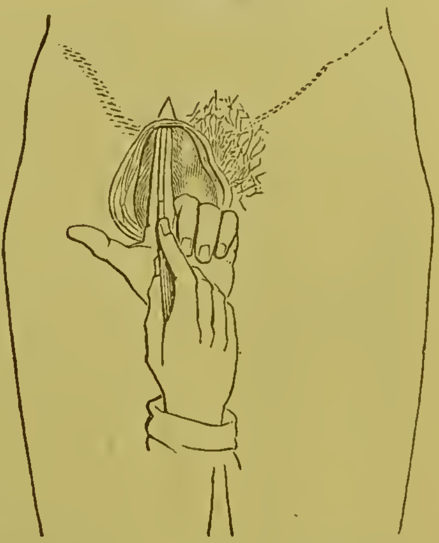


Fig. 801.

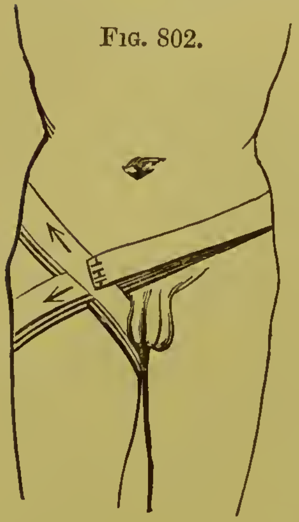


The seat of stricture is then sought for by gently examining the visceral contents of the sac. Situated commonly at the neck of the sac, the stricture must be divided with the *hernia-knife*, protected by the finger. (Fig. 801.) The direction in which it should be used has reference to the course of the epigastric artery. In oblique hernia, this vessel lies immediately internal to the mouth of the sac; in direct hernia, it courses externally. Consequently, the knife should be turned away in the opposite direction, respectively. But, owing to the dragging pressure, inwards, of an old-standing oblique hernia, it comes to stimulate a direct hernia,—the artery, however, still being *internal*. Hence, the safest direction for using the knife, and dividing the stricture in either form of inguinal hernia, is neither outwards nor inwards, but directly *upwards*. This should be observed as an absolute rule, and it is the injunction of Sir A. Cooper and Lawrence. The remainder of the operation, as to the reduction of intestine, omentum, or both, and the management of any adhesions, must be conducted according to the general rules already given.

This operation is more or less extensive, in proportion to the completeness or incompleteness of the hernia; as scrotal, or a bubonocele. In rare cases, the absence of a sac may perplex the operator; as in inguinal hernia of the cæcum, sigmoid flexure of the colon, or urinary bladder. Reduction cannot perhaps be accomplished, when the stricture is divided, and the protrusion must be left *in situ;* but afterwards, it has sometimes disappeared spontaneously.

In the *female*, the operation is precisely the same; merely substituting the round ligament for the spermatic cord, in the inguinal canal; and the labium pudendi for the scrotum, in scrotal hernia.

FIG. 802.



After the operation—whether in the male or female—a compress or pad of lint is laid upon the inguinal canal, guarding well the internal ring, and retained in position by a spica-bandage (Fig. 802); the thigh being slightly flexed on the abdomen, to ease the bandage if necessary. Eventually, a proper and well-fitting truss must be worn.

Successful results have followed the operation for ordinary strangulated inguinal hernia, at a very early period of life, only a few weeks or months, as well as in advanced age. Lawrence narrates some such cases in his well-known work.

Congenital Hernia requires a special adaptation of the foregoing treatment, and principally with reference to the situation of the testicle,—as found in the scrotum, or above the external abdominal ring, and perhaps in the abdomen. When, as usual, the testicle has descended into the scrotum, the hernia may be reduced, and a truss applied; which should be worn for a considerable period, not less than two years, in the hope of inducing adhesion of the neck in the inguinal canal, and thus a permanent radical cure. Children, who are naturally restless, and in whom the hernial parts are small, may generally be fitted more conveniently and precisely, with an air-pad truss. When the testicle has not descended, the hernia must be returned as often as it comes down; but no truss should be worn, lest it close the vaginal sheath of peritoneum and so preclude the descent of the testis.

The radical cure of congenital hernia, by operation, has proved successful. This seems to be the *only* form of inguinal hernia in which Mr. Birkett considers an operation for radical cure to be applicable, and that all other kinds should be rejected as unsuitable. He alleges as the reason for this exclusive selection, the insufficiency of evidence to show that an acquired hernial sac ever becomes obliterated by any process of natural cure, excepting in very rare cases; and that the principle of the radical cure of hernia, by surgical interference, should be, and is in fact, an imitation of some such natural mode of cure. It is unnecessary to raise this question further; suffice it to say that the results of the operation for radical cure, Mr. Wood's in particular, are such as to amply justify a more extended recourse to this practice in inguinal hernia—whether congenital or ordinary hernia.

Strangulated congenital hernia will require an operation for its relief; and the urgency is greater even than in strangulation of ordinary oblique inguinal hernia, owing to the tighter constriction of the narrow neck, especially in adults. Attempts at reduction by *taxis*, therefore, should not be long continued, a few hours only being sufficient to induce strangulation and gangrene. The peculiarities met with in the operation are: that the *stricture* is almost always situated in the *neck* of the sac, which must be opened to divide it—and thus the extra-peritoneal mode of operation is ineligible; the narrow neck of peritoneum must always be divided in its entire length, from the external to the internal abdominal ring; the *sac* is the *tunica vaginalis;* it frequently contains a large quantity of serous fluid, clear or dark coloured, and the *testicle* at the bottom of the sac is in contact with the visceral protrusion, which may be both intestine and omentum, adherent frequently to the testis. Lastly, division of the stricture may always be directed upwards and outwards with safety; the hernia necessarily being oblique, and lying therefore external to the epigastric artery. *After*-treatment may present some difficulty in the application of a compress and bandage, owing perhaps to the situation of the testis—when undescended. If this organ be in the abdomen, pressure must not be continued to obliterate the peritoneal communication; if it lies in the inguinal canal, it can perhaps be drawn down a little so as to apply the pad over the inner abdominal orifice. This operation is more fatal in its results than those of ordinary inguinal hernia. In eight cases by Professor Spence, there were four deaths.

In the *female*, the operation is precisely similar; the hernial descent taking place in the analogous vaginal process of peritoneum, known as the canal of Nuck, which ensheaths the round ligament of the uterus, as it passes down within the inguinal canal.

Encysted hernia.—The operation presents the peculiarity of a double sac; an anterior one, the tunica vaginalis, enveloping the true peritoneal hernial sac. (See Fig. 792.) The former, therefore, is first opened, exposing a serous cavity, but no hernial contents; behind lies the hernial sac, invested externally by the glistening surface of the opened tunica vaginalis, the conjoined surfaces forming a double serous layer; the hernial tumour, with the testis attached below, is remarkably movable, and readily tumbles out through the aperture in the tunica vaginalis, as a pyriform mass, suspended only by its attachment to the margin of the external abdominal ring. Proceeding with the operation, the double serous layer is divided, thus opening the hernial sac; which contains, as in other herniæ, intestine, omentum, or both. The stricture will usually be found at the neck of the sac; this is divided, and the operation completed by reducing the protrusion.

Radical Cure.—The ancient, or even some of the more modern methods of procedure, for the radical cure of inguinal hernia, do not merit any particular notice. Such were the applications of various ointments, plasters, the actual cautery, caustics; royal stitch, punctum aureum, excision, or ligature of the sac; ligature of the sac without including the spermatic cord, with or without excision, as practised by Schmucker and Langenbeck; and obliteration of the neck of the sac by the pressure of a strong tight truss, as recommended by Richter and L'Estrange. The modern operations are those of Schuh, Rigg, Belmas, Velpeau, Pancoast, Bonnet, Gerdy and Signoroni, Wurtzer, and John Wood of King's College Hospital. Of these operations it will suffice to describe more particularly those of the last three named authorities; and the following summary of them all is gathered from Mr. Wood's treatise on Rupture.

The operations may be classed under two heads. *First*—those which deal with the interior of the *sac only*, with the view of causing *adhesion* of its opposed surfaces to each other; upon the principle of the radical cure of hydrocele. This has been attempted in various ways—namely, by a simple seton of threads, candle-wick, or sponge, passed through the sac by a needle or other instrument. Such are, briefly, the methods practised by Schuh of Vienna, and Rigg of New York. Belmas of Paris passed into the interior of the sac a bag of goldbeater's skin, which was then distended with jelly to induce irritation of the sac. Velpeau in Paris, and Pancoast in New York, injected into the sac a solution of tincture of iodine or cantharides.

Assuming that these methods of obliterating the sac are without peril to the life of the patient—which for many of them is a very liberal concession indeed—a simple adhesion of the surfaces of the sac itself will not prevent the formation of another sac from the abundant and loose peritoneum of the internal opening; the real, effective boundaries of the inguinal canal and rings being left as patulous as before. This was long ago pointed out by Lawrence in his able treatise on Ruptures. With this class may be associated the operative procedure of Bonnet of Lyons, which consists in passing needles across the sac and its coverings; thus pinching them up, as they emerge from the superficial ring. The anterior part only of the sac, and below the inguinal canal, is regarded in this procedure; leaving the upper and posterior portions, and the tendinous boundaries, unaffected. The result is the temporary retention of the hernia in the canal, and an ultimate return to its former condition; with the further disadvantage of a constriction or incomplete adhesion, opposite the point operated on, which increases the liability of strangulation. The ultimate condition of the parts was invariably unsatisfactory.

The *second* class of operations are based upon a different principle—*invagination* of the skin and fascia of the scrotum, so as to form a plug up the hernial canal.

Gerdy's method.—The skin of the scrotum, containing some portion of the fundus of the hernial sac, is pushed up into the superficial ring upon the finger of the operator. A curved needle, armed with strong ligature thread, is then carried along the finger, and thrust through to the surface of the groin on each side of the point of the finger. The ligature is then tied up, so as to hold the invaginated sac and skin in their new position, till adhesion has taken place in the interior of the canal. Signoroni used a piece of catheter for invaginating; while Gerdy attempted further, to cause adhesion of the opposed surfaces of the hollow cone of skin by removal of the cuticle by caustic ammonia, and by placing sutures at the mouth of invagination—a proceeding which is usually futile.

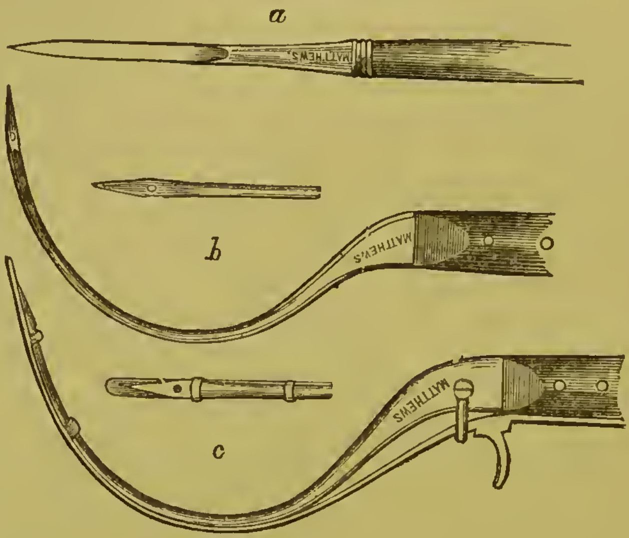
Wurtzer's method.—In this modification of the operation by invagination, the forefinger is first introduced to push up the integuments and fundus of the sac through the external abdominal ring and inguinal canal, as high as the internal ring; a boxwood hollow plug is then introduced, as the finger is withdrawn, and a long flexible needle passed along its interior is thrust through the invaginated skin and sac, thence outwards through the anterior wall of the inguinal canal. A grooved piece of wood is then laid over that part, and held in position by the projecting point of the needle at its extremity, while the lower end is fixed by a screw to the plug, so as to compress the invaginated integument and sac. The object is to distend the inguinal canal and rings by the plug, and to compress by the screw; thus to induce adhesive inflammation between the opposed surfaces of the invaginated integument and sac up to its mouth. In this way, by preventing the unfolding of these parts, a permanently inverted cone may result, closing up the hernial canal. Hence the plug is retained for an apparently sufficient period for this purpose, usually about seven days. This procedure, originating with Wurtzer of Bonn in 1838, followed by Rothemund in Munich, and Sigmund in Vienna, was introduced into this country by Mr. Spencer Wells in 1854, and subsequently advocated by Redfern Davies and others. Mr. Davies suggested that the plug should be made to expand like a glove-stretcher, so that it may fill out the internal ring.

The failure of all these operations is not due to peritonitis; when a fatal result has ensued, it has generally been owing to suppuration and the burrowing of matter between the abdominal layers, and sometimes consequent on pyæmia. But either mode of operation by invagination commonly proves ineffectual for a complete and permanent cure. In Gerdy's thirty-six cases, most, if not all, had a relapse of the hernia. Wurtzer's method seems to have been, from Mr. Wood's inquiries, entirely unsatisfactory in its results. With very few exceptions, the rupture re-descended soon after the plug was withdrawn, or whenever the constant use of a truss was discontinued. A very general impression—he adds—prevails among Surgeons, both in this country, in France, Germany, and the United States, that none of the foregoing operations have given such promise of satisfactory results as to bring them into general use.

Wood's Operation.—The novel principle originated by Mr. Wood, for the radical cure of inguinal hernia, consists in the compression and closure of the tendinous sides of the hernial canal throughout its *entire* length; this principle prevailing in the various methods proposed and practised by this author. Thus characterized, they differ entirely both from the older and more modern operations; all of which either deal with the sac almost solely, or rely upon the principle of dilatation or plugging of the canal. Moreover, unlike that of Schmucker, Langenbeck, and others, Wood's operation is of an entirely subcutaneous character. The sac, if punctured at all, is pierced by a small and valvular opening only, and remains deep-seated away from exposure. And the connections between the sac itself and the layers of deep-seated tissues, are not broken down or interfered with, being traversed only by the needle and ligature.

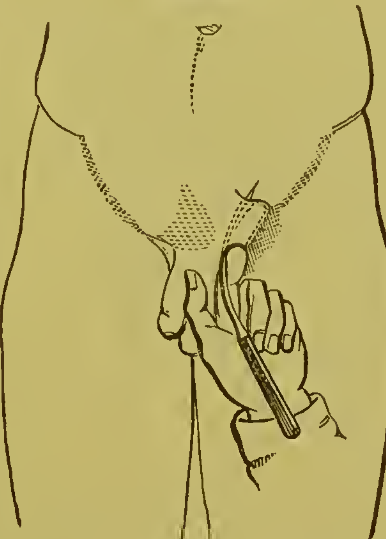
Instruments.—The operation, as practised by Mr. Wood, requires certain instruments (Fig. 803): *a*, a small fascia-knife; *b*, a stout unyielding curved needle mounted in a strong handle; *c*, guarded needle; a piece of stout copper wire silvered about two feet long, or a stout hempen thread of sufficient length well waxed and then soaped; and a compress of boxwood, glass, or porcelain, long and broad enough to cover the hernial canal. Wire is usually selected, and the operation is performed in the following manner, under the influence of chloroform to relax the abdominal muscles.

Fig. 803.



The patient lying recumbent with his shoulders well raised, and the pubis and scrotum cleanly shaved, the Surgeon will find it most convenient to stand on the side of operation, and to invaginate with the forefinger of the right hand on the right side, and *vice versâ.* The hernia having been carefully and completely reduced, an assistant should command by pressure the internal ring, if there be any tendency to protrusion. An incision is then made with the tenotomy-knife, through the skin of the scrotum, over the fundus of the sac, and in direction obliquely downwards and outwards; the length of this scrotal incision being sufficient to easily admit the point of the forefinger with the needle. If the hernia be a bubonocele, the seat of the scrotal incision should be one and a half inches below the spine of the pubis. The knife is next turned flatwise between the skin and the fascia, and carried subcutaneously around the edges of the incision, so as to detach the one from the other over an area of at least two inches in diameter; or to a wider extent in a large hernia. Next, the knees of the patient should be brought together and bent up to relax the inguinal structures; the operator's forefinger is then passed, with the nail backwards, into the scrotal aperture, and made to invaginate the detached fascia into the inguinal canal, invagination being commenced at as low a point as possible, so as to force the finger as much as may be behind the hernial sac between its fundus and the spermatic cord, and passed up as high as possible in the canal towards the internal abdominal ring. Hooking the finger well towards the surface, the lower border of the internal oblique muscle will be felt raised upon it, and more distinctly recognized by placing the other hand upon the surface of the groin. By directing the finger inwards, the conjoined tendon, raised with the muscle, will be felt at the thumb side. The needle unarmed, and oiled, is then passed along the same side of the finger, and pushed through the tendon, then obliquely upwards and inwards through the internal pillar of the external ring, till the point is seen to raise the skin of the groin; and this manœuvre should be carefully preceded and covered by that of the finger. The skin is drawn in the same direction, obliquely upwards and inwards, as far as its attachment will allow, and the point of the needle made to emerge. (Fig. 804). One end of the wire is then connected with the eye of the needle, and the instrument withdrawn by a quick jerk, carrying the wire in its course after it, out through the scrotal aperture, the other end of the wire projecting through the puncture above. Directing the invaginating finger behind the external pillar of the ring to opposite the internal ring, as close as possible to Poupart's ligament, in the groove between the spermatic cord and the ligament, the needle carrying the ligature is passed along the curve of the finger, and pushed through the aponeurosis of the external oblique at the above point, when the skin is drawn upwards and outwards until the needle can be brought through the puncture before made. A loop of the ligature is then left in the puncture, and the needle withdrawn, carrying the free end. In the operation as more *recently* practised by Mr. Wood, the needle is *disengaged* from the wire, when withdrawn from the scrotal aperture—after making the puncture through the conjoined tendon; and then it is passed *unarmed*, in making the second puncture, through the aponeurosis of the external oblique at Poupart's ligament. The opposite end of the wire there projecting, is then connected with the eye of the needle, and drawn through the puncture in the course of the needle, out through the scrotal aperture; and the instrument is again disengaged.

Fig. 804.



Thus, two ends of wire emerge together from the lower or scrotal aperture, after traversing the conjoined tendon and internal pillar on the inner side, and Poupart's ligament at the outer side; while the loop connecting them emerges at the upper or groin aperture. (Fig. 805.)

The sac of the hernia and investing fascia opposite the scrotal aperture, is then pinched up between the finger and thumb, and the spermatic cord slipped back, as in the operation for tying the veins in varicocele. The needle is then passed from without inwards and slightly upwards in the direction of the incision, across the scrotum, close to and in front of the spermatic cord; the needle entering and emerging entirely within the limit of the scrotal incision. If, however, the skin be accidentally punctured, the incision may be extended to meet that point. One of the ends of wire, the inner more conveniently for the purpose of compression, is then again hooked on to the needle, and drawn with it across the cord through or behind the sac, traversing the scrotal fascia. (See Fig. 805.) Then, the ends of the wire are to be drawn down, until the loop above is close to the skin; here it is fixed by the finger of an assistant, while the Surgeon twists the ends round each other, giving them three or four turns. This manœuvre twists the enclosed sac and fascia which are held between the ends of the wire. Lastly, the loop is drawn steadily upwards, so as to invaginate the twisted sac and scrotal fascia firmly into the inguinal canal, up to the internal abdominal orifice. The loop is then, in its turn, twisted well down into the upper or groin aperture, giving it the same number of turns. Certain manipulations will enable the operator to determine whether all is secure; by placing his forefinger on the scrotal aperture, he may judge whether the external ring is closed satisfactorily by the tightening of the wire, and the effect of traction on the wire upon the posterior wall can also be distinguished. Great care should also be observed that the scrotal skin is not drawn upwards between the pillars of the ring, which would prevent their direct union. The projecting ends of wire are cut off by pliers, about three inches from the surface, and hooked up under the loop; both forming an arch over the intervening skin. A roller is then lodged beneath the arch (Fig. 806), and a broad spica-bandage applied to make firm compression upon the roller, as steadied by the arch of wire.

FIG. 805.

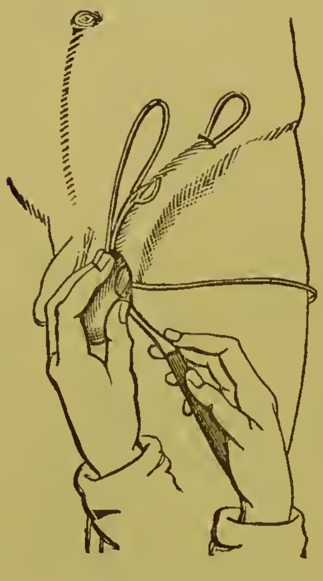
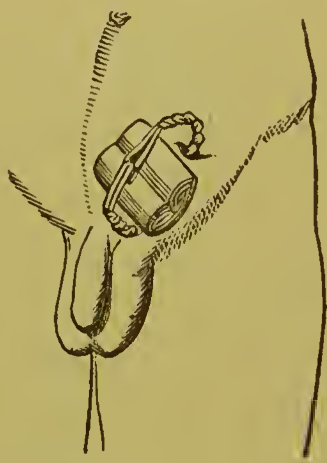


FIG. 806.



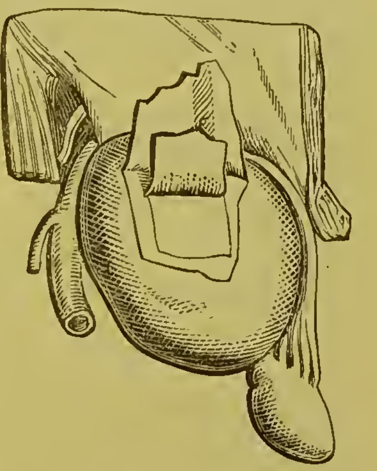
The period for untwisting the wire is about the eighth or tenth day, and it may be removed about the fourteenth, or as late as twenty-one days when consolidation takes place slowly. It should be withdrawn through the upper puncture, thus not to disengage the invagination. A truss must be worn eventually, and Mr. Wood recommends the horseshoe-pad truss, of sufficient strength to support but not to compress, with a pad formed to make flat pressure, and over the neighbouring parts as well as the obliterated canal. Cases have been treated entirely without truss.

The *results* of this operation give the encouraging proportion of 65 to 70 per cent. of successful cases; without reckoning doubtful and imperfect cases, and with a fair allowance for imperfect records and future casualties. This average percentage is also drawn from entirely unselected cases, as presented; oblique and direct, good and bad, many of them of a very aggravated kind, some of enormous size, and treated by operative procedures some of which were more or less tentative.

Irreducible hernia.—Inguino-scrotal hernia, when irreducible, often attains a large size. It must be supported in a bag-truss, and thus also somewhat protected from injury.

FEMORAL OR CRURAL HERNIA.—*Course.*—This form of hernial protrusion descends vertically below Poupart's ligament, through the crural ring and canal; lying in the sheath of the femoral vessels, internal to the femoral vein. Emerging from beneath the sharp upper margin of the saphenous opening in the fascia lata—that portion known as the upper cornu, or the femoral ligament, of the falciform border or process of Burns—the hernia comes forward, in front, through the opening, and then turns upon itself abruptly, upwards, towards Poupart's ligament,—thus overlaying the portion in the crural canal; so that the upper cornu of the falciform border and the crural sheath intervene between the superficial and deep portions of the hernial protrusion. This curved course of femoral hernia is very important in relation to the direction of pressure necessary for reduction; it being requisite that the protrusion should be made to retrace its course, downwards, backwards, and upwards.

FIG. 807.*



Anatomical Coverings, and Relations.—The layers of different textures which femoral hernia receives, successively, in its course from the crural ring, externally, are as follows:—peritoneal pouch forming the sac, sub-serous cellular tissue or septum crurale over the opening of the crural ring, fascia transversalis forming the anterior portion of the femoral sheath,—which with the septum crurale constitutes the *fascia propria* of Sir A. Cooper (Fig. 807); and over the saphenous opening, the cribriform fascia or deep layer of the superficial fascia, with the superficial layer of this fascia containing fat, and then the skin.

These anatomical coverings are interesting in their relation to the development of femoral hernia; but, as in other forms of Hernia, the coverings become so altered and amalgamated as to lose their importance surgically. To persons who are fond of enumerating hernial coverings, it may be observed that the investments of femoral hernia are essentially the same as those of inguinal hernia, less two: the intercolumnar fascia and the cremasteric fascia, in oblique inguinal;

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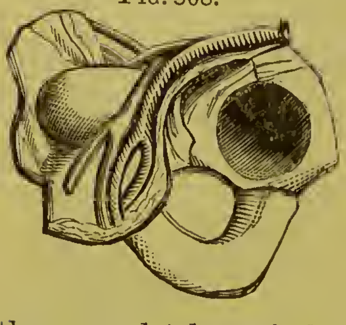
* Roy. Coll. Surg. Mus., 1345. Large femoral hernia, in the male; showing the *fascia propria*. On the inner side of the sac, the spermatic cord is pushed inwards; externally, the sac overlaps the femoral vessels, and extends to within half an inch of the anterior crural nerve. The sac contained part of the right colon, adherent, but not strangulated. In the preparation, posteriorly, the epigastric artery is shown, running tortuously from the upper border of the sac. (Howship.)

the intercolumnar and the conjoined tendon, in direct inguinal hernia. While, therefore, either form of inguinal hernia has seven anatomical coverings, femoral hernia has only five; although these may be subdivided anatomically, as if to show their pathological and surgical insignificance.

The relations of femoral hernia to surrounding parts are far more important. The *crural ring*, an aperture of oval shape, and about half an inch wide, is bounded—internally, by the base of Gimbernat's ligament and the margin of the conjoined tendon behind it; anteriorly, by Poupart's ligament with the curved band of the deep crural arch, the spermatic cord, or the round ligament in the female, lying above Poupart's ligament; externally, by the femoral vein with the innermost septum of the crural sheath; posteriorly, by the pubes, its horizontal ramus, covered by the fascia lata,—its pubic portion being prolonged over the pectineus muscle up to the pectineal line of that bone. The position of *vessels* around the crural ring is specially important with reference to the direction in which the stricture of femoral hernia at that aperture may be most safely divided. Commonly, the ring is partially surrounded by vessels; on the outer side, by the femoral vein, and at the upper angle by the epigastric artery; anteriorly, the pubic branch of the epigastric runs to the back of the pubes, and more removed from the aperture lie the spermatic vessels of the cord. Thus, then, the ring is encircled by vessels, excepting internally and posteriorly. An abnormal origin of the obturator artery may, however, give an additional vascular relation to the ring. Sometimes this artery arises from, or with, the (deep) epigastric, and in its course to the notch in the obturator foramen, it may have either of two positions relative to the crural ring; passing down more frequently on the outer side,† or arching over and down on the inner side (Fig. 808), at the base of Gimbernat's ligament, an occasional course which occurs once in about eighty operations (Lawrence). In the one position, the inner side of the ring is still free from any vessel; in the other, it is then completely encircled with vessels, except posteriorly in its relation to the pubes.

FIG. 808.*



The small pubic branch from the epigastric, which runs to the back of the pubes, may perhaps pass downwards near the inner side of the crural ring to anastomose with the branch from the opposite side; or a similar branch, descending on the inner side of the crural ring, may join the trunk of the obdurator (Fig. 809); or again, the epigastric artery, having its unusual origin from the obdurator or from the femoral artery, may, it is said, ascend under and on the inner side of the ring.

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* Roy. Coll. Surg. Mus., 1348. Femoral hernia; showing the obturator arising by a common trunk with the epigastric artery, and the obturator passes over and round the *inner* side of the neck of the sac. The length of the common trunk is about eight lines. (Liston.)

The same irregular course of the obturator artery (in common origin with the epigastric) exists on both sides, in the preparation of a *double* femoral hernia. (St. Bartholomew's Hosp. Mus., 17, 69.)

† See Ibid., 1346. Femoral hernia; showing the epigastric and obturator arteries arising by a common trunk, and the obturator passes downwards on the *outer* side of the crural ring, between the neck of the sac and the external iliac vein. (Howship.)

The *crural canal* is the innermost space in the interior of the crural or *femoral sheath;* the femoral vein, and external to it, the femoral artery, being likewise contained in this sheath. (Fig. 810.) The latter is formed by a prolongation from the fascia transversalis of the abdomen, with a prolongation from the iliac fascia covering the iliacus muscle. Both fasciæ thus named, are only different parts of the same membrane, and are continuous along the line of Poupart's ligament external to the iliac vessels; here, the one passing down in front, and the other behind the vessels, as they become femoral under Poupart's ligament, the two portions of fascia together form a loose funnel-shaped sheath, enclosing the vessels,—in addition to their common cellular investment. This sheath narrows as it continues downwards to about two inches below Poupart's ligament, where its distinctive appearance is lost in the common cellular investment. Its outer border is straight, and perforated by the genito-crural nerve; its inner border is oblique, and appears in the saphenous opening, transmitting the saphena vein and lymphatics. Two very thin septa divide the sheath into three compartments; one septum passes between the femoral vessels, each of which is thus placed in its own compartment, while the other septum lies on the inner side of the vein, and defines the compartment known as the crural canal. This canal is about half an inch in length, reaching only from the base of Gimbernat's ligament to the

FIG. 809.*

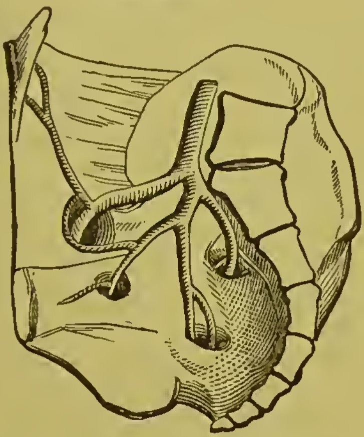
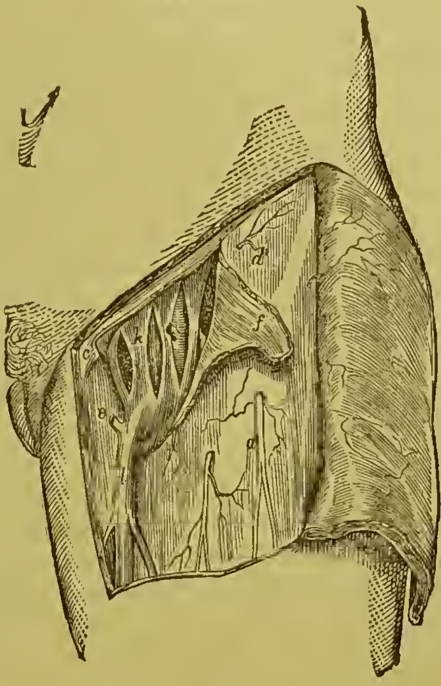


FIG. 810.†



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* Roy. Coll. Surg. Mus., 1347. Right side of a male pelvis; showing the epigastric artery given off by the external iliac, a quarter of an inch above the crural arch; and about two-fifths of an inch from its origin, a branch, nearly a line in diameter, is given off, and descends, winding round the *inner* margin of the crural ring—as the obdurator courses in Fig. 808. After turning round the ring, this branch passes under it, goes towards the foramen ovale, and joins the trunk of the obdurator, which is of its ordinary size, and springs, as usual, from the internal iliac. The junction of the two vessels takes place about half an inch previous to their united trunk leaving the pelvis. (Liston.)

† Dissection of groin; showing the three compartments in femoral sheath. (John Wood.)

upper cornu of the saphenous opening. Anteriorly, the sheath forming the canal is overlaid by the upper cornu of the falciform border of the saphenous opening; posteriorly, is the pectineus muscle covered by the fascia lata, its pubic portion. Externally, is the femoral vein and inner septum of the sheath, already noticed; internally, the sheath alone bounds the canal, owing to the oblique direction upwards of its anterior boundary,—the upper cornu of the falciform process inclining upwards, to join the base of Gimbernat's ligament.

The *saphenous opening*, for the transmission of the saphena vein and superficial lymphatic vessels, is formed by the division of the fascia lata into an iliac and a pubic portion. This opening has an important relation to femoral hernia, in the course of its development. Situated about half an inch below Poupart's ligament, and rather to the inner side of the middle line of the thigh, it is of an oval form, and extends from the superior cornu downwards to the inferior cornu, or about one inch and a half in length, and its width is about half an inch. The inner border is ill defined, and lies on a plane posterior to the outer margin and the femoral vessels; the pubic portion of the fascia lata, forming this border, passes upwards underneath the sheath of the vessels, over the subjacent pectineus muscle to the pectineal line of the pubis. The outer margin—falciform border or process of Burns—is anterior to the inner border; it is firmer and well defined, of a semilunar or falciform shape, and its concavity looks downwards and inwards. It is connected by fibrous bands to the sheath of the vessels. The *upper* portion of this firm margin, corresponding to the crural canal, has a direct relation to the *development* of crural hernia; and the rigidity of the whole falciform border of the saphenous opening, especially in its bearing on the canal, is much affected by the position of the limb; extension and rotation outwards having the effect of tightening the margin, while flexion and rotation inwards relaxes it. At the saphenous opening, the *inner* aspect of the sheath of the femoral vessels is uncovered; but the opening is closed in by the thin, deep layer of the superficial fascia, which is connected with the margin of the opening, and more firmly with its external or falciform border. This membrane is, however, weakened by the transmission of certain vessels; at the lower part of the opening, by transmitting the saphena vein, and by numerous small apertures in the fascia,—hence named cribriform, for the passage of the superficial lymphatics. Any resistance which the membrane might otherwise offer to a hernial protrusion is lessened by this defective support. The subjacent portion of the femoral sheath is pierced by the same vessels, and weakened accordingly.

When the hernia has escaped through the saphenous opening, and turned up over the crural canal towards the abdomen, its *return* is much affected by the state of the saphenous opening, and of its upper portion in particular.

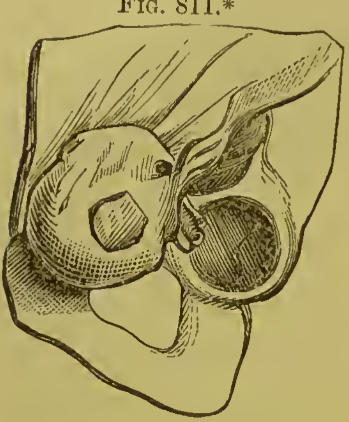
Seat of Stricture.—The strangulation of femoral hernia may be situated either at the crural ring, and caused by the base of Gimbernat's ligament with perhaps the margin of the conjoined tendon, internally, and Poupart's ligament with the band of the deep crural arch, in front; or, at the margin of the saphenous opening, and caused by the falciform border, its upper cornu in particular as it arches over the hernia escaping from the crural canal. These are the situations of stricture pointed out both by Hey and Lawrence. From examination of the parts in cases after death following the operation, I am convinced that the principal seat of stricture is the base or sharp margin of Gimbernat's ligament; the bowel having been deeply indented so as to exactly correspond with this structure, when the two were replaced in apposition.

Thickened bands of fascia propria, situated about half an inch below the crural ring, across the neck of the sac, may also be an occasion of stricture; so as to constrict and indent the neck. This was noticed by Sir A. Cooper, and it is specially adverted to by Mr. Luke.

Varieties of femoral hernia, characterized by the course of the sac, may be here noticed, as being rare and curious. Le Gendre describes four such varieties:—(1.) *Crural hernia*, in front of, or *external to, the femoral vessels*; instances of which are described by Cloquet, Hesselbach, Stanley, and Partridge. (2.) *Pectineal crural hernia.*—The hernia, as soon as it traverses the crural ring, passes directly internal to and *behind* the femoral vessels, and rests on the pectineus muscle, the aponeurosis of which may form an envelope to it. This is sometimes denominated Cloquet's hernia, he having first described it. Callisen, Vidal (de Cassis), Richet, Le Gendre, and Mr. J. Adams have recorded similar cases. (3.) *Crural hernia, through Gimbernat's ligament.*—This variety is situate internal to the femoral vessels, but it passes directly through the resisting Gimbernat's ligament. It is the hernia of Langier, who first noticed it; and Cruveilhier, Demeaux, Nuhn, and Le Gendre have also dissected cases of this kind. (4.) *Crural hernia, with a diverticulum through the cribriform fascia.*—The hernia traverses several openings in the cribriform fascia, and thus forms several distinct lobes, which give it a very characteristic appearance. This is the hernia of Hesselbach, who first described and figured it; and Le Gendre and Malgaigne have also dissected examples. (5.) *Crural hernia, with a diverticulum through the superficial fascia.*—A variety in which the hernia, having escaped beneath Poupart's ligament and traversed the cribriform fascia, sends one or more prolongations through the superficial fascia. It is the hernia of Sir A. Cooper, and Le Gendre has furnished a dissection and drawing of such protrusion.

Signs, and Diagnosis.—The tumour of femoral hernia presents certain distinctive characters. It is situated below Poupart's ligament by about half an inch or the length of the crural canal, and to the inner side of the femoral vessels, but external to the spinous process of the pubes. These relations have reference to the *neck* of the tumour, and femoral hernia may thus be distinguished from inguinal, whether this be a bubonocele or scrotal hernia. At first the swelling is generally of small size,—not larger perhaps than a Spanish nut or walnut; but it may soon increase to the size of an orange, and rarely attains to much larger dimensions, although it seldom acquires the size of inguinal hernia. The shape of the tumour is tolerably rounded, and it extends upwards to Poupart's ligament, assuming a transversely elongated form; rarely, it overlaps the femoral vessels externally, and passes downwards upon the thigh. (Fig. 811.) In point of consistence, the hernial tumour will of course vary with the contents of the sac,—as to the presence of intestine, omentum, or both,—an entero-epiplocele; and the quantity of serous fluid in the sac will also affect its tension. But the size of the protrusion also renders it harder or softer; a small hernia, particularly a knuckle of intestine, deeply seated in the angle between the body of the pubes and the femoral vessels, forms a tense unyielding lump—perhaps scarcely visible, and feeling like an enlarged lymphatic gland; while a fully developed, hemispherical hernia has a soft, doughy consistence. The reducibility of the tumour, and its varying size, according to posture, straining or coughing, and the impulse then communicated, are all additional signs of its hernial nature.

Fig. 811.*



Females are much more subject to crural hernia then males. Perhaps this greater liability may be owing to the larger size of the crural ring in the female. But, as compared with inguinal hernia, the much more common *occurrence* of femoral hernia, as generally supposed, is not verified by Kingdon's statistics, to which I have already referred. The relation of femoral hernia to *age*, in the female, is remarkable, and explains the numerical equality of the two forms of hernia. Before puberty, inguinal hernia is common, whilst crural is extremely rare. Of 193 girls affected with hernia before fifteen years of age, 184 were cases of inguinal, and only nine crural rupture. Even to the age of twenty years, the one is much more common than the other form of hernia; and in a total of 1442 hernial cases in females, at *all* ages from birth upwards, the majority of crural hernia over inguinal was only fifty-four.

After twenty years of age, crural hernia is much more commonly developed than inguinal, and it occurs most frequently between the ages of twenty and forty—*i.e.*, during the prime of life in women. This peculiarity is due to that being the period of life when parturition is also most frequent, whereby the abdominal walls become much stretched and relaxed; and Mr. Kingdon's statistics show that this has a greater tendency to develop crural rather than inguinal hernia. In 680 ruptured women, 262 had the one, 178 had the other form of hernia. The first pregnancy also has the most predisposing influence, as regards either form of hernia; subsequent pregnancies seem to have an almost invariably declining tendency.

Diagnosis from *other tumours, in the femoral region.*—*Psoas abscess* differs from femoral hernia, in its situation, the characters of the tumour, and its history. The abscess presents below Poupart's ligament, but to the *outer* side of the femoral vessels. It is partly at least reducible in the recumbent posture; but careful palpation with either hand alternately, above and below Poupart's ligament, demonstrates a corresponding subsidence and enlargement in these situations, as of fluid passing to and fro. The antecedent symptoms of pain in some part of the dorsal or lumbar spine, and constitutional disturbance, will corroborate the diagnosis; any impulse on coughing notwithstanding. *Iliac* abscess may point at the crural ring, but the history and constitutional cachexia will be diagnostic, although associated with impulse on coughing, and a reducible swelling. *Cysts* occasionally form in the neighbourhood of the crural ring, and associated with hernia, or existing alone. The fluctuation on pressure, with persistence of the swelling and its invariable size, will mainly determine the nature of the case. *Venous dilatation*, or a *varix*, may occur at the saphenous opening. Any such enlargement is reducible like hernia, but pressure above will cause the swelling to be reproduced. The characters of varix are also marked, as to the thrill and murmur, and the varicose enlargement of the vein below the crural tumour. *Enlarged crural lymphatic glands* may be distinguished from hernia, by the aggregated character of the swelling, its persistence on pressure, and by the absence of any impulse on coughing. The history of the case will also be corroborative. An omental hernia, presenting a somewhat irregular swelling, and having an obscure impulse, most nearly resembles an enlargement of these glands; but they may then be distinguished by the mobility of the tumour, which can be drawn away, or lifted up from the crural ring. A single enlarged gland, situated over or in the ring, offers the most difficult diagnosis. But although the little glandular swelling may be tender or painful, the symptoms of strangulation do not ensue. *Fatty tumour*, of small size, and situated in the crural canal, has occasionally been met with. It closely simulates hernia. The soft and doughy character of this growth contrasts with the tense consistence of crural hernia, similarly placed; the irreducible character of the swelling, and the absence of impulse on coughing, are also distinctive.

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* Roy. Coll. Surg. Mus., 1350. Femoral hernia, of large size; and having increased equally in all directions, it overlaps the crural arch, and extends outwards over the femoral vessels, also inwards and downwards. (Taunton.)

The *coexistence* of any femoral tumour or swelling with femoral hernia renders the diagnosis more or less difficult. And especially if the hernia be of small size, and concealed by the tumour. Thus, enlarged and suppurating femoral glands, overlying a small hernial protrusion, may simulate strangulation. But the main points of distinction are the history of such enlargement, with the coexistence of any cause of lymphatic irritation; coupled with the absence of constipation and vomiting.

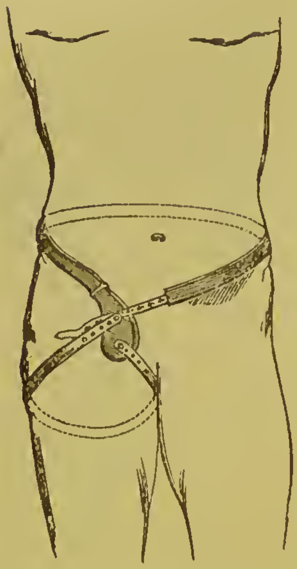
Treatment.—This must have reference to the state of the hernia; as reducible, irreducible, or strangulated.

Reducible femoral hernia must be treated in the usual manner; the protrusion returned by taxis into the abdomen, under the influence of chloroform, and a proper truss applied, and worn, over the crural aperture. The *direction* in which manipulative compression should be made is specially important. Remembering the course of femoral hernia, a fully developed protrusion should be returned by gentle pressure, downwards from Poupart's ligament, in order that it may turn the sharp upper corner of the falciform border of the saphenous opening, then directly backwards as if into the thigh, and upwards, through the crural canal. In short, the hernia is unfolded as it were, and made to retrace its course into the abdomen. During this manipulative proceeding, the Surgeon should avail himself of a relaxed state of the saphenous opening, by flexing and rotating the thigh inwards.

The size of the truss-pad should vary with the degree of laxity of the part, and chiefly as regards Poupart's ligament. A small, convex pad will generally prove sufficient support; but a lax state of the ligament will require a larger and flatter pad.

Femoral Trusses.—Three principal forms of femoral truss have been devised, which are thus described by Mr. Bigg. All possess the ordinary steel spring pelvic belt. (1.) The spring is curved downwards, so as to rest above the femoral region, and is fitted there with a pad, so shaped (Fig. 812) as to exercise pressure just below Poupart's ligament when the patient flexes the thigh upon the body, as in walking or sitting. (2.) Another form of femoral truss is furnished with an inflated india-rubber pad. This is admirably suited for old-standing cases; and proves effective, even when the patient is racked with cough or undergoes severe muscular exertion. (3.) The pad is self-adjusting, attached to the spring by a steel blade. This variety is useful for horse exercise. When the hernia is of large size, or when it comes down under the fascia lata, it is necessary to use a thigh-belt, with a triangular pad projecting on the inner surface; forming a soft continuation of the support, to fill the space where the cribriform fascia occupies the saphenous opening of the fascia lata. The peculiar form of the femoral pad made by Messrs. Matthews (Fig. 813), as designed by Mr. John Wood, answers this purpose even more effectually.

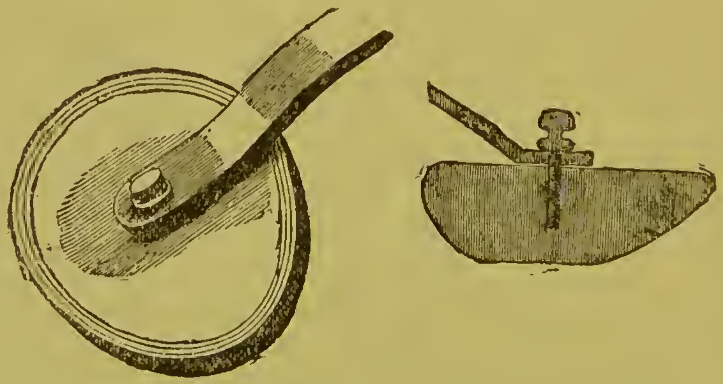
Fig. 812.



The hernia rarely, if ever, undergoes a radical cure, in consequence of wearing a truss; thus differing unfavourably from inguinal hernia, which may occasionally be cured by this method of treatment.

Strangulated Hernia.—Both Pott and Astley Cooper allude to circumstances which are of vital importance in the treatment of crural hernia; namely, the difficulty often experienced in the reduction of small recently developed enterocele, the rapidly progressive injury to the bowel, and the severity of the accompanying constitutional symptoms. Mr. Bryant found only thirty-eight cases reducible by taxis, out of 142 cases of strangulated crural hernia admitted into Guy's Hospital. Ten of these cases were herniæ of recent development, and strangulated on their *first* recognized descent. Hence the Surgeon should always search for a hernial tumour, however unsuspected by the patient. Reduction having failed, and symptoms of strangulation being persistent, an operation for the division of the stricture and liberation of the hernial protrusion must be had recourse to, as soon as possible. This rule of early operation is even more imperative in

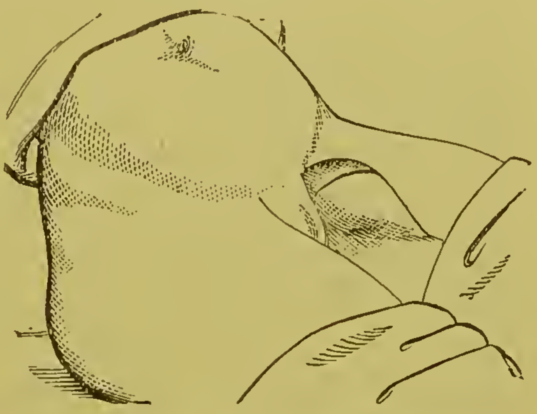
Fig. 813.



femoral than in inguinal hernia; for, owing to the tight and unyielding character of the stricture in the crural ring, delay would be the more dangerous.

Operation.—The general principles already laid down with reference to operation for the relief of strangulated hernia, are here applicable. In regard to femoral hernia, the stricture may be divided *external* to the sac, and the protrusion returned without opening the sac, and this limited procedure is sometimes effectual; when *internal*, it will become necessary to open the sac, in order to divide the stricture from within. The patient lying recumbent, chloroform having been administered, the parts shaved, and the bladder emptied; an incision is made by pinching up and transfixing a fold of skin, transversely across the tumour on its pubic aspect, and inclining inwards, so as to reach the seat of stricture. (Fig. 814.) This latter direction is the special feature of Mr. Gay's admirable modification of the operation—that the incision be placed on the inner side of the neck of the tumour. If the sac be not opened, the operative procedure is thus simply the taxis, plus a slight incision. Other forms of incision are occasionally convenient; a transverse line may be added obliquely, along Poupart's ligament, as thus ᛚ; or the inverted ⊥ of Sir A. Cooper, or the inverted ⅄ of Sir W. Fergusson. The superficial fascia is then divided, and any little hæmorrhage restrained which might obscure the dissection, by pinching or twisting any bleeding arterial vessel. A round tumour is now exposed, having a peduncle curving upwards into the abdomen, at the angle between the body of the pubes and the junction of Poupart's ligament with the spinous process. This is the hernia, but invested with the fascia propria—the femoral sheath of fascia transversalis united with the subperitoneal cellular tissue, which may be loaded with fat, and occasionally studded with small cysts. Accordingly, the fascia propria may be thin and membranous; or thickened, and present an almost omental appearance, especially in old-standing hernia long subject to the pressure of a truss. In the one case, the sac lies immediately underneath the fascia; in the other, the sac is buried within its substance. But, however this fascia may resemble the peritoneal sac, it may be distinguished by observing that the one is continuous with the margin of the hernial aperture, whereas the other is there defined, and constricted by it. Passing the finger up on the neck of the tumour, the sharp upper margin of the saphenous opening in the fascia lata will be felt constricting the neck; and immediately behind this, the junction of Poupart's ligament with the base of Gimbernat's ligament may also be the seat of stricture. These strictures should be divided successively; first, the falciform border at its upper cornu, in order to find the necessity for proceeding a little more deeply to Gimbernat's ligament. Introducing a hernia-knife

Fig. 814.



along the curve of the finger, or on a curved director, or insinuating its point between these ligamentous constricting bands and the neck of the tumour, just to within the crural ring, this double stricture can be overcome by dividing it *upwards* and *inwards*—on thus obliquely directing the cutting portion of the knife. It yields with the usual creaking sound and sensation; and a very limited extent of incision will prove sufficient. Having divided one or both strictures, the hernia may not unfrequently be reduced, without opening the sac, by gently compressing its contents. Sometimes, however, another source of stricture still exists, in the form of thickened bands of fascia propria, situated about half an inch below the crural ring, across the neck of the sac, constricting and indenting it. These should be divided, as Luke recommends, by insinuating the nail of the finger under them from above, and carrying the point of a probed bistoury along the nail, with its blunt edge towards the sac.

But if this fails to liberate the hernia, or if the symptoms of strangulation have become thoroughly established, even to stercoraceous vomiting, and the visceral protrusion may have suffered also by prolonged taxis, it will then be necessary to proceed to lay *open the sac.* The fascia propria must first be divided carefully on a director. When thin and membranous, the sac is at once exposed; when thick and fatty, and perhaps cystic, this must be done cautiously, by making more than one layer with the knife and director, lest the sac be inadvertently opened and its visceral contents be wounded. On the other hand, it must be observed not to *make* a sac of one of the artificial layers of the fascia propria, and then, mistaking the true sac for intestine, not to open the hernial sac at all. This latter sac having been fairly exposed, it is opened in the usual manner; a small button-hole incision being made by means of the forceps and knife used flatwise, and the aperture enlarged on the broad director, upwards and downwards; the seat of stricture is then sought for, commonly at the thickened peritoneal mouth of the sac, and this must be divided upwards and inwards, as being the direction of least risk to any vessel adjacent to the crural ring. Sometimes, the ligamentous or fibrous structures external to the neck of the sac having been divided, the mouth of the sac can be sufficiently dilated by gently introducing the point of the finger, without any further use of the hernia-knife. The contents of the sac and any adhesions are then dealt with according to the general rules already given. An entero-epiplocele is usually found; and the omentum lies mostly in front, enclosing and concealing a knuckle of intestine.

Hæmorrhage, perhaps considerable and persistent, is liable to occur in dividing the stricture at the crural ring. This accident is peculiar to femoral hernia, and it has led to a fatal result occasionally, in addition to the ordinary hernial contingency of peritonitis. I have lost one case, owing to the continuance of hæmorrhage internally; and Guthrie states that some of the best Surgeons have lost patients by hæmorrhage after the operation for femoral hernia. It proceeds from the obturator artery, that vessel having its unusual origin from the epigastric artery, and the more unusual course of then arching over the ring and descending on the inner side at the base of Gimbernat's ligament. This vessel will then be across the knife in dividing the stricture upwards and inwards. Sometimes, the small pubic branch from the epigastric, running to the back of the pubes, passes downwards near the inner side of the ring to anastomose with the branch from the opposite side; or again, the epigastric artery, having its unusual origin from the obturator or from the femoral artery, may ascend on the inner side of the ring. The same liability to hæmorrhage would then occur, in dividing the stricture at the crural ring. Any such unusual source of hæmorrhage it will be difficult to anticipate or control. Before introducing the hernia-knife, it might be practicable to feel the pulsation of the aberrant artery with the tip of the finger. When cut, the vessel may perhaps be drawn to the aperture and tied, or twisted at both ends; or the hæmorrhage may be arrested by plugging with lint or sponge, and by cold applications. Secondary hæmorrhage will necessitate a fair exposure of the vessel, by cutting down in the course of the hæmorrhage, and tying whatever vessel bleeds. Occasionally, an artery bleeds which at the time of operation did not; it will then scarcely be justifiable to cut down and explore for an unknown source of hæmorrhage, and the only expedient is a cold application.

A compress and spica-bandage must be applied, to prevent the recurrence of protrusion.

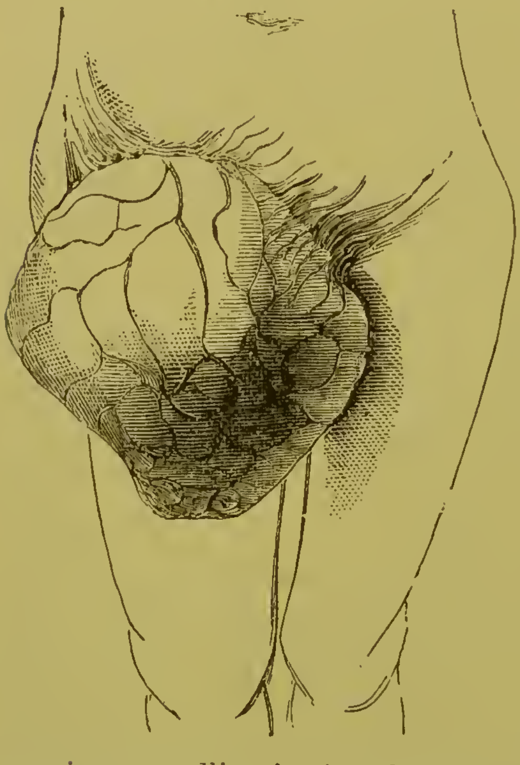
A too free division of the stricture at the crural ring, unattended with hæmorrhage, may be followed by an increased liability to hernial protrusion, after recovery from the operation. This result is owing to a weakened state of Poupart's and Gimbernat's ligaments at their angle of junction. The truss, worn eventually, will then require the additional support of a cross tongue, buckled on to its free end.

Radical Cure.—Little has hitherto been done to effect a radical cure of femoral hernia by operative procedures. The operation of invagination into the hernial aperture was performed in one case by Dr. G. Jameson, of Baltimore, North America; and in another case, with a hard plug retained by sutures, as performed by Mr. Redfern Davies. Both patients survived, but the results with regard to the recurrence of hernia seem to have been very doubtful.

An operation proposed by Mr. J. Wood, but practised only at present on the dead subject, is performed in the following manner; the instruments used being the same as for inguinal hernia, by the wire operation. The body lying recumbent, with the shoulders raised, a vertical incision about an inch long is made through the skin over the site of crural hernia. The fascia around the margin of the wound is detached subcutaneously to a sufficient extent for invagination, free from skin, fairly into the crural opening. Then, pressing the femoral vein outwards with the forefinger which is used for invaginating, the needle is passed backwards—through the sac were it present—sufficiently deep to take up the pubic portion of the fascia lata covering the pectineus muscle; the point of the needle being afterwards made to emerge in the wound. It is then carried forwards and upwards, and made to transfix Poupart's ligament close to the nail of the invaginating finger. The skin of the groin is drawn outwards by an assistant, and the point of the needle pushed through it. The wire is then hooked on to the eye of the instrument, and drawn back with it into the wound. Disengaging the needle, leaving the wire protruding, it is passed again through the pubic portion of the fascia lata, about an inch or three-quarters of an inch—according to the size of the hernial aperture—to the inner side of the first perforation; and the point made to pass through Poupart's ligament directly above, and close to the curved border of Gimbernat's ligament, including a portion of its fibres. Drawing the skin inwards until the needle can be pushed through the same puncture before made, and which is already occupied by one end of the wire, the opposite end is hooked on to the needle and drawn back with it, when that end also is disengaged. The two ends of the wire are now twisted down into the incision, and cut off about six inches from the twist. The loop which emerges at the upper puncture is then twisted firmly down in it, pressing down before it that portion of Poupart's ligament opposite the crural opening, which is included in its grasp. A roller of lint, or a boxwood or glass compress of cylindrical form, is applied and kept in position by the ends of wire drawn over it, with pledgets of lint on each side; and over all, a spica-bandage.

By this operation, that part of the tendinous crural arch which overrides the neck of the sac is drawn backwards and downwards, so that it may become adherent to the pubic portion of the fascia lata included in the suture. In a large hernia, the sac and its coverings would be transfixed, and embraced in the suture; in a small hernia, the serous sac might easily be returned into the abdomen, and its tendinous investments united altogether external to it. The result might be, that the invaginated fascial and sac coverings would become adherent on all sides, under the combined influence of ulceration, traction, and pressure; and thus forming a consolidated mass, filling up the area of the crural ring, a radical cure might be accomplished. Its permanency would require the test of time.

Fig. 815.*



Certain parts, contiguous to the operation, should be carefully avoided; the femoral vein,—by interposing the finger between it and the needle during the passage of that instrument; the bowel, the epigastric artery, and in the male, the spermatic cord,—by not pushing the needle too far into the abdominal cavity.

Irreducible Hernia.—Crural epiplocele very often becomes irreducible, but enterocele in this state is equally rare. The tumour may attain to large dimensions, equalling in size a large scrotal hernia, and losing the appearance of femoral hernia. (Fig. 815.) No other treatment can be pursued than to support and protect the hernial protrusion by a truss with a hollow pad; and this whether it be epiplocele or enterocele.

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* Royal Free Hospital. (Author.)

Comparative Estimate of Inguinal and Femoral Hernia.—The following conclusions seem to be established by Mr. Bryant's analysis of 126 fatal cases of Hernia:—

That *inguinal* hernia is more common than femoral; commences earlier in life; is less liable to strangulation on its first descent, and generally exists twenty years before it becomes so; requires operation less frequently, but is more fatal; is less often associated with gangrenous bowel, but more commonly with ulceration at the line of stricture.

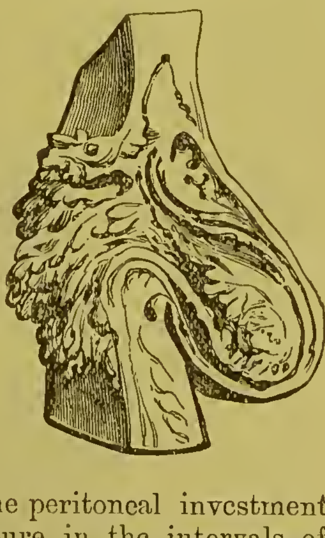
That *femoral* hernia is less common than inguinal; seldom appears before fifty years of age; is more frequently strangulated on its first descent, but generally averages eleven years' existence; more frequently requires operation, but is less fatal, and is generally strangulated for a longer period before being relieved; after operation, is more often followed by sinking, and by gangrenous bowel and artificial anus; but is less commonly associated with ulceration at the line of stricture and fæcal extravasation, unless from rupture by the taxis, an event which is more liable to happen.

UMBILICAL HERNIA.—*Exomphalos* or *Omphalocele*, as umbilical hernia is also sometimes called, signifies a visceral protrusion through the umbilical aperture; in common language, ruptured navel. The *course* of the protrusion, in this kind of hernia, is straight through the abdominal wall.

The hernial sac is always an acquired extension of the peritoneum, there being no process analogous to the inguinal vaginal process of this membrane. Yet umbilical hernia is sometimes described as of two varieties: the *congenital*, with reference to its formation in infants from birth; and the acquired variety, which is developed in *adults*. In the one condition of hernia, the protrusion passes through the umbilical aperture, either before the cord is detached, or before that aperture has closed; in the condition of later or adult life, an aperture is formed by a separation of the fibres of the linea alba at the formerly closed umbilical ring or an immediately adjoining part, in consequence of its having stretched or yielded before the protrusion from within.

The anatomical *coverings* of umbilical hernia are those of the abdominal wall, at the umbilical aperture. Taken from within outwards, in the order of hernial development, they are successively—a pouch of parietal peritoneum or the hernial sac, with subperitoneal cellular tissue containing fat, and the fascia transversalis, then a prolongation from the tendinous margin of the aperture, the superficial fascia, and skin. (Fig. 816.) Before the separation of the umbilical cord, the protrusion may pass through the navel-opening, directly into the substance of the cord, which thus forms a peculiar covering to the hernia. In a suddenly produced umbilical hernia, the peritoneal investment may be partly deficient, apparently from rupture in the intervals of the finely fibrous reticulated appearance which the peritoneum here naturally presents; the covering derived from the tendon of the ex-

FIG. 816.*



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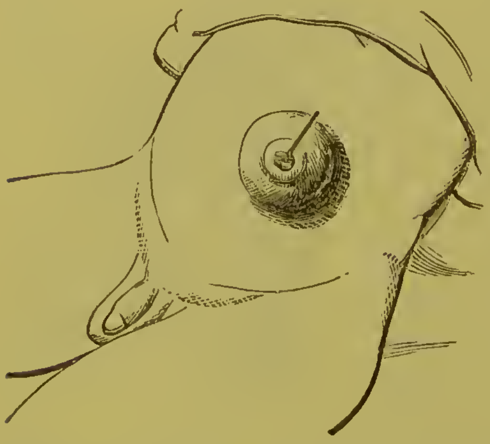
* Roy. Coll. Surg. Mus., 1356 A.

ternal oblique muscle may be wanting; or in a large, old hernia, a similar state may have resulted from prolonged distension, and the fat, subcutaneous, in the superficial fascia, or that over the peritoneal investment, may have disappeared. All the coverings are often inseparably united together, so that the common covering is frequently very thin, and the contents of the sac become more or less perceptible. The umbilical aperture forms a very firm and unyielding tendinous margin around the neck of the sac, itself somewhat thicker at this part than over its expanded part or body. The mouth of the sac is often large in proportion to the bulk of the protrusion. As the hernia increases in size, the varying anatomical relation of the umbilical aperture becomes important. The tumour does not extend uniformly upon the anterior surface of the abdomen, but downwards towards the symphysis pubis more than in any other direction. Occasionally, the transverse diameter of the tumour exceeds the vertical, or it may be pyriform and suspended by a peduncle or stalk. Sometimes, it is sessile, with a base almost as large as its body; or it may be only apparently so, and when elevated is found to have a small stalk, thus resembling a mushroom in shape. The visceral contents of umbilical hernia are, usually, both intestine, large or small, and omentum—an entero-epiplocele; and in a large hernia, nearly the whole intestinal canal, small and large intestine, may be found enveloped by omentum. The latter sometimes becomes firmly adherent to the sac, or bands are produced by which the intestine becomes entangled; while by hardening and contraction of the omentum, this portion of the protrusion forms anomalous masses within the sac. Other viscera, occasionally, are included, as the stomach, liver, spleen, or uterus; in one case, Murray found that the gravid uterus, at the eighth month of pregnancy, formed the contents of an umbilical hernia.

When *congenital*—existing at the time of birth—the hernia is formed by a dilatation of the umbilical cord, the protrusion separating the constituent vessels of the cord, so that the umbilical vein lies above, and the arteries on one side or below. This dilated portion of the cord contains a peritoneal pouch, enclosing usually a knuckle of small intestine.

FIG. 817.



The *stricture* in this kind of hernia, is the firm margin of the umbilical ring. Rarely, the sac having given way, the extruded bowel or omentum has become strangulated in the peritoneal aperture; instances of which occurred in the practice of Sir A. Cooper.

Certain *signs* in connection with the tumour are characteristic. The hernia commences as a small, soft, projecting ovoid swelling, at the navel. (Fig. 817.) It gives a distinct impulse on coughing, but is readily reducible by gentle pressure with the finger; and a small aperture is then felt, having a firm sharp border. On removing the finger, the skin remains relaxed and creased in the fossa of the navel; or it unfolds and distends, until the tumour reappears as before. As the hernial protrusion increases, the tumour assumes other forms, according to the anatomical relations of the umbilical aperture, in point of its size and position with regard to the protrusion. Hence a pendulous tumour is presented, semilunar transversely, or pyriform, with the aperture towards its upper part; or a round, flattened, and sessile, or nearly stalkless tumour. In the *congenital* form of umbilical hernia, the tumour consisting of a dilated portion of the cord, it may be recognized by its smooth, translucent appearance, the skin around the base of the swelling not being prolonged over the cord. The base of the tumour corresponds with the umbilical aperture; from the apex the cord is continued.

Umbilical hernia often attains a large size, and an irregular shape as if consisting of several tumours, owing probably to the yielding of its fascial or tendinous coverings at different parts; it has also a partly doughy and tympanitic consistence, according to the visceral nature of its contents. Lumps of feculent matter are apt to accumulate in the intestine when protruded, and which can be readily felt through the thin sac and lax abdominal coverings. Accordingly, the patient often suffers from dyspeptic symptoms and constipation. But the mechanical inconvenience of a large umbilical protrusion is an additional source of distress to the person thus afflicted. The tumour hanging down perhaps to the pubes, any exertion becomes burthensome, and the thin skin which encloses the mass readily excoriates. When adhesions to the sac have taken place, the tumour is proportionately irreducible.

This kind of hernia occurs mostly in infancy, at birth before the cord is detached, or before the umbilical aperture has closed; or in adult life, and indeed at any period of life; and in both sexes. Females are most liable, and especially those who have borne many children, or have a tendency to abdominal obesity. Ascites is sometimes attended with an umbilical protrusion, but which contains only the fluid of dropsy.

The immediate cause, as in other herniæ, is some straining effort of the abdominal muscles; as by the act of crying in children, coughing or parturition in adults and females.

Treatment.—Reducible umbilical hernia should be returned, and then a proper truss-support must be fitted, and worn, over the hernial aperture. Reduction is accomplished by gently compressing the swelling directly backwards, raising it slightly from below the navel where the larger portion of the protrusion rests. At the same time, the abdominal muscles should be relaxed by flexing the thighs towards the belly, and somewhat elevating the chest; although this position of the patient has less effect than in other herniæ, as the resistance is principally due to the tendinous character of the umbilical aperture, and the abdomen is often lax and pendulous. Some time may be required to return the protrusion, which is often of large size; and owing to the nature of its contents, I have found it necessary to knead back into the abdomen masses of feculent accumulation, before the bowel could be returned, followed by omentum. After reduction, the Surgeon proceeds to close the umbilical aperture with a properly adapted truss. In infancy, an elastic india-rubber belt, with an air-pad, affords the most effectual support; or a simpler and more ready contrivance is a slice of cork covered with leather, so as to form a firm, flat compress over, not in, the aperture, and retained by a broad piece of adhesive plaster. Thus supported, the aperture has a strong natural tendency to close, in two or three months. In adults, a suitable truss must be worn, made on the same principle as for the hernia in infancy. The annexed figures represent the most appropriate forms of Truss. A broad elastic bandage, of such width as to support the whole weight of the abdominal viscera, and carrying a pad which rests upon the umbilical aperture and localizes the force there. (Fig. 818.) Another form, suited for severe cases, is a lightly constructed steel truss. (Fig. 819.) Matthew's "reflex action" pad (Fig. 820) guards the umbilical aperture, and is self-adapting. The *radical cure* by operation has been performed by Mr. Wood, in three obstinate cases. He applied a small pair of rectangular pins vertically, and in opposite directions, one on each side of the opening, transfixing the edge of the tendinous aperture and making them emerge close to each other through the integuments above and below the opening. When locked into each other, and twisted, the edges of the aperture were drawn close together in a line with the linea alba, so as to protrude the integuments and sac of the rupture in a vertical fold above them. The pins were surrounded and the skin protected by strips of lint and plaster, and were retained four days, without any unpleasant symptoms. They were then withdrawn, and the edges of the aperture had firmly united. A pad and circular bandage were used for a short time, and the child was discharged from the Hospital. While under observation, the rupture had not returned. An *invaginating* operation has also been performed by the same Surgeon, on the principle already fully explained with regard to inguinal and femoral herniæ. The details of this procedure are given in Mr. Wood's Treatise. Respect-

Fig. 818.

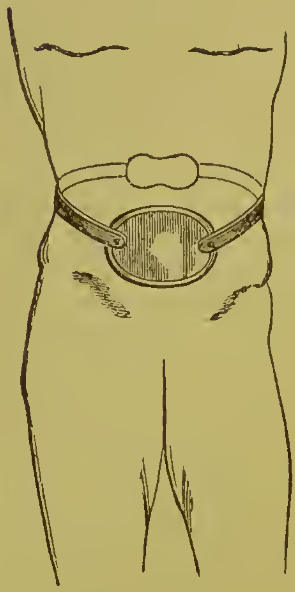


Fig. 819.

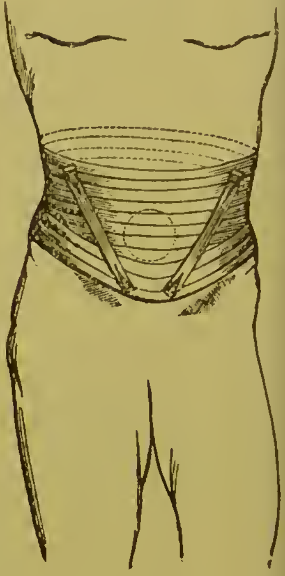
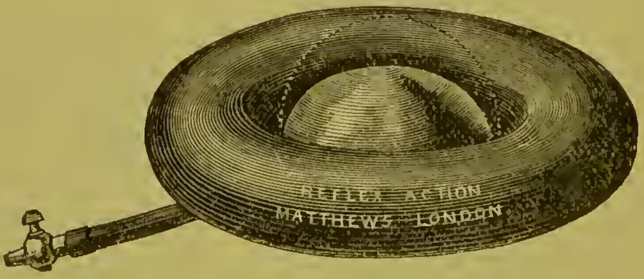


Fig. 820.



ing its applicability, it is said that, in favourable cases of umbilical hernia in the adult, this operation may be tried with but little danger, considerable probability of success, and the certainty of not rendering the state of things worse by interference. Other Surgeons have successfully effected a radical cure by operation; Mr. Barwell on three patients at the respective ages of six months, fifteen months, and eight years; and Mr. H. Lee has also cured cases on the plan of the operation already described. Desault revived an old operation,—the application of a *ligature* around the base of the umbilical tumour, care being taken to first empty it of its contents. Strangulation is followed by detachment in a week or ten days, when the hernial aperture may have become united, and is obliterated as the ulcer heals. In more than fifty consecutive cases, this method of treatment is said to have proved a radical cure. On the same principle, Mr. C. Heath, in a case of strangulated umbilical entero-epiplocele, having returned the bowel, dissected the sac away, and passing a ligature through its base and the omentum, these were then removed. Recovery ensued, and some time after no hernial protrusion had recurred. But the principle of these operative procedures cannot be recommended; for experience has shown that ligature of the sac of peritoneum often causes symptoms of strangulation as if the intestine were involved; cases of this kind having occurred in the practice of Petit. The mere removal of the sac would be useless. In femoral hernia this procedure was resorted to by Sir A. Cooper, but the hernial protrusion soon returned. Considering the strong tendency to a natural cure, in *infancy*, when the abdominal aperture is properly supported and for a sufficient period, it will always be a serious question whether any cutting operation is justifiable.

Irreducible umbilical hernia must be treated on the usual principle of support and protection by means of a bag-truss, or a concave metal shield, padded, which I have known to afford great comfort. Much relief may be obtained from the constipation and dyspeptic symptoms which occur, by occasionally kneading back into the abdomen the masses of feculent matter which accumulate in the intestine, when protruded, and the hernia is of large size. The diet and state of the bowels must be constantly regulated.

Strangulation rarely arises. The symptoms of obstruction and nausea or vomiting, may be those of incarceration, and are mostly dependent on a flatulent and loaded state of the intestinal canal; and this can generally be overcome by purgatives and enemata, with re-employment of the taxis a second and a third time, at intervals of two or three hours. On the other hand, the symptoms of true strangulation are very insidious in umbilical hernia, especially when the tumour is old-standing and irreducible. Consequently, timely recourse to operation must not be overlooked.

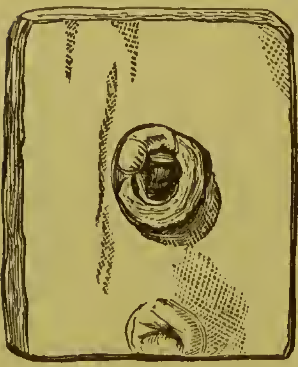
The operation is very simple. An incision in the middle line over the upper part of the neck of the tumour, and to about two inches in extent, will generally suffice to reach the constriction at the umbilical aperture. A longer incision, unless absolutely requisite, might allow of further protrusion, convolutions of intestine rolling out during each act of expiration. The constriction would thus be obscured, and the bowel liable to be punctured. This incision should be superficial,—passing through the skin only, and the fascial coverings should then be carefully divided—using a director, as the sac is soon reached; the finger-nail is inserted under the firm margin of the aperture, and the stricture slightly divided upwards, without opening the sac, and the hernia returned into the abdomen; or, if reduction cannot thus be effected, the sac must be opened, and the constriction divided within, upwards in the same line as the first incision. The omentum and bowel are then managed on general principles. Any other situation around the neck of the tumour may be selected for operation, when more convenient with regard to the position of the neck; and the stricture may be safely divided at any such point in the circumference of the umbilical aperture, there being no vessel fairly within the way of the knife in any direction. This operation has been performed during pregnancy, a complication not much affecting the case, and instances of successful results are recorded by Sir A. Cooper and Lawrence.

After the operation, under any circumstances, a large flat pad-compress must be applied over the hernial aperture, and retained in position by a broad flannel roller.

In the event of artificial anus resulting from a gangrenous state of the bowel, as a rare occurrence in umbilical hernia, this complication must be treated on the general principles already explained.

Ventral Hernia signifies a protrusion through any other part of the abdominal wall, except the apertures already noticed. Commonly, this hernia takes place at the linea alba (Fig. 821), the linea transversæ, or more externally, at the lineæ semilunares. The anatomy of ventral hernia may be inferred from the particular part of the abdominal wall, which happens to yield; any such protrusion is usually the result of some lacerative or rupturing injury, favoured perhaps by some natural weakness, or over-distension of the abdominal wall. The characters of the tumour are similar to those of umbilical hernia, and the treatment is the same; but, as the hernial aperture is generally ill-defined and perhaps of some size, the broad, flat swelling can be more easily reduced, and seldom is followed by the symptoms of strangulation. Careful examination of the abdomen may be necessary to discover the protrusion when deeply imbedded in a fat person, for no tumour may then be perceptible on the surface.

Fig. 821.*



Lumbar Hernia may be described as a variety of the preceding; but the tumour projects in the loins, between the crest of the ilium and the last rib. Cloquet first drew attention to hernia in this situation. It arises usually from contusion or laceration of the lumbar muscles. Dr. Chapplain relates the case of a man who, after a violent squeeze between a wall and a carriage, found a tumour in his loin; and Mr. Kingdon saw a case where the bowel protruded just above the crest of the ilium at its highest point, about three inches from the spine, in

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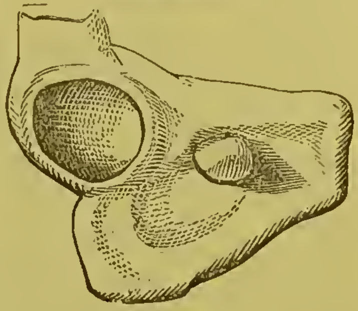
[*] St. Thomas's Hosp. Mus., R. 100. Ventral hernia; showing the protrusion to be above the umbilicus. Between the sac and fascia there is a layer of fat. In the posterior part of the preparation, the umbilical vein would be seen to pass into the mouth of the sac. (Sir A. Cooper.)

the linear interval between the quadratus lumborum and abdominal muscles.

OBTURATOR OR THYROID HERNIA.—A very rare form of hernia in which the protrusion takes place through the obturator foramen. It was first noticed by the elder Arnaud, afterwards by Duverney, and described more particularly by Garengeot in the early part of the last century; since also by Huermann, Cloquet, Vinson, Stanley, Hilton, Tebay, Obré, and Bransby Cooper; and Birkett has collected twenty-five cases. The protrusion having escaped from the pelvis through the obturator canal (Fig. 822), it is developed underneath the pectineus muscle, and in the pubic region of the thigh. The neck of the sac lies behind the horizontal ramus of the pubes, and occupies the obturator canal; the sac may then be confined between the obturator membrane and obturator externus muscle; or the protrusion makes its way, sometimes between the uppermost fibres of the obturator muscle, sometimes above them, and then the fundus and body of the sac is covered by the fascia of that muscle. The obturator vessels and nerve have a variable relation to the tumour; the artery has been found to the outer side, or to the inner side, and less frequently, behind the sac. In Stanley's case, both artery and nerve were above the sac; the former to its inner side, the latter towards its outer. The contents of the sac are usually both intestine and omentum,—an entero-epiplocele; but only a portion of the calibre of the ileum may have descended, and be prolonged into a diverticulum of considerable length. In one case, the Fallopian tube and ovary formed the contents of the sac; in another, a portion of the urinary bladder.

FIG. 822.*



Symptoms.—A small hernial tumour is more or less palpable and visible, situated below Poupart's ligament, in Scarpa's triangle and towards the pubes. There may be a slight fulness only to the eye, in the part of the thigh which is naturally hollow; but on deep pressure with the fingers, a hard lump is felt. In the female, examination per vaginam should be made. No tumour, however, can be detected in a large majority of cases; and the existence of hernia has not been discovered during life. Strangulation has been known to supervene, without any local signs of a tumour. Acute pain in the course of the obturator nerve is the most marked symptom in all cases; pain occurring suddenly with the formation of the hernia, and proceeding from the upper and inner part of the thigh; thence extending down the inside of the limb to the knee, front of the leg, foot, and great toe. Pressure over the site of the external aperture of the obturator canal gives rise to paroxysms of pain of great severity.

Both sexes are liable to the formation of this hernia, and females especially.

Diagnosis.—From *crural* hernia, a protrusion through the obturator canal may be distinguished by observing the relative positions of the horizontal ramus of the pubes and femoral vessels. These parts, with the pectineus muscle, intervene between these two forms of hernia; in the one, they are behind the hernia and cannot be easily felt, not perhaps until it is reduced; in the other, they are in front of the tumour, which is therefore deep-seated, while the ramus and the pulsation of the artery can be felt superficially. With symptoms of strangulation and no tumour, there will still be the acute pain proceeding from the site of the obturator canal, and extending downwards along the inner side of the limb. But exploration of the obturator region, by means of an incision, will alone clear up the difficulty; and this procedure is justifiable with a view to relieving the symptoms of strangulation by operation.

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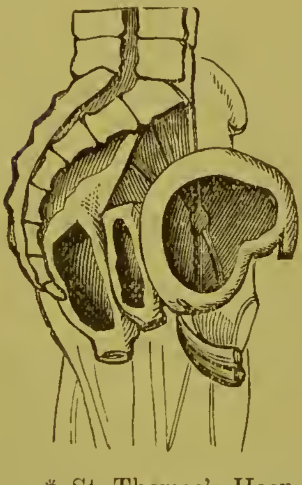
* St. Thomas's Hosp Mus., R. 104. Obturator hernia, on the right side. The protrusion is of small size; and the obturator vessels and nerve pass through the foramen on the outer side of the neck of the sac.

Complications may be occasioned by the coexistence of one or more herniæ, especially in the inguino-femoral region. Thus, in one case, there was reducible crural hernia on either side; in three cases, a crural hernia on the same side as the obturator; in one case, on the opposite side; and in another case, an inguinal hernia on the same side as the obdurator. Two obturator herniæ, one on either side, have been known to coexist, in some cases.

The *treatment* is necessarily tentative, owing to the obscurity of diagnosis. If a hernial tumour be detected, it may be reduced by pressure so directed as to free the protrusion from the ramus of the pubes, and pass it underneath it. Otherwise, in the event of symptoms of strangulation, with or without a hernial tumour, an exploratory operation must be resorted to. The incision should be either parallel with the trunk of the femoral artery, or with the border of the adductor longus muscle. Avoiding the femoral vein, the fascia covering the pectineus muscle and this muscle must be cautiously divided; some fat and the fascia of the obturator muscle are then reached. The tumour lies under this fascia, or possibly under the muscle, between it and the obturator membrane. The neck can be felt at the obturator canal, and the obturator nerve must be avoided.

FIG. 823.*



PERINEAL HERNIA descends between the prostate gland and rectum; or between the vagina and rectum in the female,—the sex perhaps most liable. The peritoneal sac escapes between the anterior fibres of the levator ani, and is covered by the pelvic fascia. It usually contains intestine, but omentum will scarcely descend so low down; occasionally, a portion of the urinary bladder protrudes. A tumour of hernial character is presented in the perineum, at the side of the anus. (Fig. 823.) By examination with the finger through the rectum, a hernial descent may be discovered before its appearance in the perineum. The protrusion having been replaced, the patient should wear a padded T-shaped bandage. Perhaps a rectal pessary will afford additional support. In the female, there is generally some prolapsus of the vagina, and a ball-shaped vaginal pessary certainly aids the perineal bandage.

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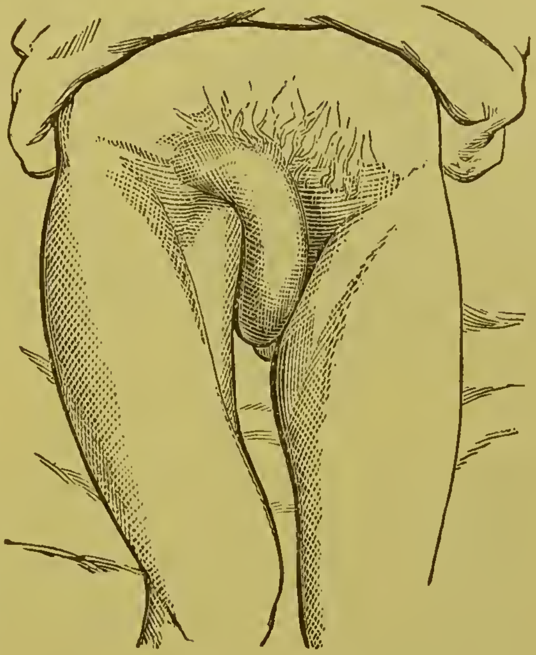
* St. Thomas's Hosp. Mus., R. 106. Perineal hernia, in the male. The sac, between the bladder and rectum, is laid open; its fundus lies before the anus, and behind the prostate and vesiculæ seminales. The bladder covers part of the anterior portion of the hernia. The mouth of the sac is distant nearly three inches from the anus. No protrusion, apparently, could be detected in the perineum. (Sir A. Cooper.)

Vaginal Hernia is a variety of the preceding, and was first distinctly recognized by Garengeot. The protrusion is covered only by peritoneum and the wall of the vagina; and forms a swelling in the vagina, instead of the perineum. It is specially liable to occur in women who have borne children. Vaginal hernia is easily reduced, as the orifice of the sac is usually large; but it must be retained by a sponge pessary, extending up to the os uteri, where the protrusion commences, and supported by a T bandage.

Pudendal Hernia descends along the vagina, but escapes from under the adjacent portion of the levator ani, between the ascending ramus of the ischium and this passage. It forms a small elastic tumour in the labium pudendi, lying in the posterior and inferior half of this part, and presenting a somewhat elongated projection at the side of the vagina.

The *diagnosis* from other tumours is important. Other labial tumours which may be confounded with pudendal hernia, comprise those formed by inguinal protrusions and by collections of fluid. Of the latter are cystic formations and hydrocele of the round ligament. These, however, are never reducible, nor diminished by pressure, and they slowly enlarge from their first appearance. From inguinal hernia (Fig. 824), the pudendal is distinguished by its position, shape, and relations. Thus, pudendal hernia has not passed through the external inguinal ring, but lies parallel with the axis of the vagina; it does not form a pyriform tumour in the labium, but a somewhat rounded mass; and it lies by the side of the ramus of the ischium, and not over the body of the pubes. From crural hernia, the diagnosis consists in the neck of the pudendal tumour being situated entirely to the inside of the ramus of the ischium and the attached muscles.

Fig. 824.*



A suitable bandage is required to support the protrusion.

Ischiatic Hernia escapes through the sciatic notch (Fig. 825), above or below the pyriform muscle; usually below, between it and the spine of the ischium. Lying in close relation with the sciatic nerve and the internal iliac vessels, the tumour forms beneath the glutæus maximus muscle; but extending further out of the pelvis, it escapes below the border of that muscle and becomes sub-integumental. The hernial tumour is of variable size, soft or tense, causing more or less pain, and reducible on pressure. When not fully developed and of small size, lying also under the cushion of the glutæus muscle, the tumour will probably not be discovered during life. On the other hand, when the tumour appears from under the muscle, it might be mistaken for a perineal hernia which has enlarged so as to occupy the ischio-rectal fossa. But then this protrusion can be traced forwards and upwards to the anus, and felt within the rectum.

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* Royal Free Hospital. (Author.)

When an ischiatic hernia is detected, it may be reduced, and retained by means of a proper pad-support and bandage.

Strangulation will necessitate recourse to operation, always a difficult proceeding in regard to the anatomical relations of the hernia; and in enlarging the mouth of the sac, Sir A. Cooper recommends that the incision be made directly forwards.

Diaphragmatic Hernia.—In this rare form of hernia, one or more of the abdominal viscera protrude upwards through an aperture in the diaphragm into the thoracic cavity. (Fig. 826.) The hernial aperture may be one of the natural openings in the diaphragm; or an opening as the result of congenital defect; but usually it is an acquired aperture, caused by laceration in consequence of a violent compression or fall, violent vomiting or coughing, or produced by a penetrating wound, as by gunshot injury. The viscera protruded are commonly the stomach or the transverse colon, with a portion of omentum. There is usually no peritoneal sac, rupture having occurred; and the hernia occurs generally

Fig. 825.*

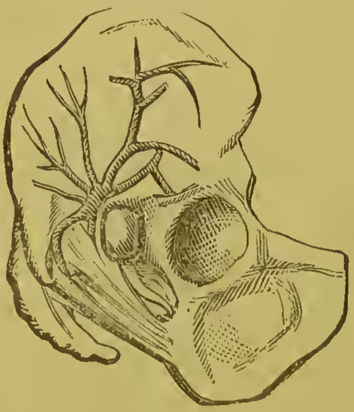
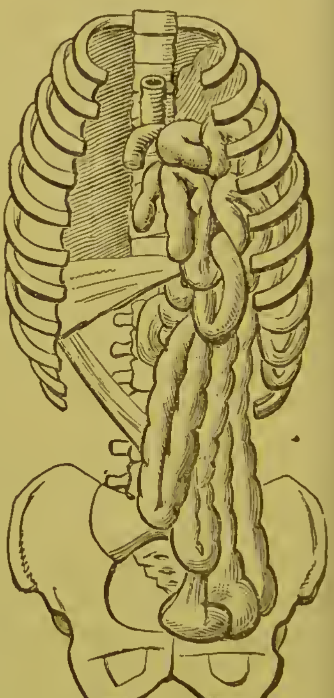


Fig. 826.†



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* St. Thomas's Hosp. Mus., R. 105. Ischiatic hernia, on the right side. The mouth of the sac is anterior to the internal iliac artery and vein, below the obturator artery, and above the obturator vein. The neck was situated anterior to, and a little above, the sciatic nerve, on the fore part of the pyriformis muscle; and the fundus, situated on the outer part of the pelvis, was overlaid by the glutæus maximus. Anterior to, but a little below, the fundus of the sac, is the sciatic nerve; behind it, the glutæal artery; above, it is near the bone, and below are the muscles and ligaments of the pelvis. On opening the abdomen, the ileum had descended on the right side of the rectum into the pelvis, and a fold of it was protruded into a small sac, which passed out of the pelvis at the ischiatic notch. Strangulation had taken place, even to sphacelus. The patient, a man aged twenty-seven, had nausea, retching, and violent pains in the epigastrium; collapse ensued, and he died on the eighth day. (Sir A. Cooper.)

† Ibid., R. 108^1. Diaphragmatic hernia.

on the left side, the liver on the right side apparently preventing its formation there.

The same *symptoms* arise as in other herniæ—constipation, vomiting, and pain; but dyspnœa is more or less urgent, and perhaps a hacking cough and bloody expectoration. The *diagnosis* from intussusception and internal abdominal strangulation will be scarcely possible, unless the thoracic symptoms be taken in connection with the abdominal. Interesting cases are recorded by Dr. Reid in the "Edinburgh Med. and Surg. Journal," 1840; and by Dr. Copeman, of Norwich, in the "Provincial Med. Journal" of 1855. The protrusion may become adherent, and thus remain fixed within the thoracic cavity; the urgency of the symptoms subsiding as the parts get accommodated, and the patient recovers. But strangulation commonly supervenes, and a fatal issue. Rare instances there are of apparently recurring diaphragmatic hernia; the symptoms coming and going, and an established aperture in the diaphragm having been found after death.

Treatment will be of little avail, the hernial protrusion naturally increasing and attaining a considerable size. Mr. Guthrie, with his characteristic boldness in Surgery, proposed that an incision might be made through the abdominal wall, large enough to admit the hand to draw back the stomach into its proper place. Overlooking the doubtful question of diagnosis, it would be difficult to prevent the liability of a protrusion through the abdominal aperture after such an operation, in itself also otherwise dangerous; and it is more difficult to understand how the replaced organ could be made to remain in its place, unless indeed the opening or rent in the diaphragm were stitched up!

CHAPTER LVIII.

INTESTINAL OBSTRUCTION.

No subject in Medicine and Surgery has a more comprehensive pathology, and the treatment of which is more frequently unsuccessful, than intestinal obstruction. Its pathology embraces numerous and diverse structural conditions of, or affecting, the intestinal canal, and in various portions of its extent; the symptoms of which in common may be simple and obvious, but their differential diagnosis is obscure; while their course and terminations are perilous or uncertain, and the treatment having reference to such conditions is proportionately ineffectual or impracticable.

The whole of this important but difficult subject has been ably considered by Mr. Pollock, who thus classifies these intestinal conditions. Excluding external abdominal herniæ of all kinds, the conditions, or causes, of intestinal obstruction may be divided into two classes: the acute, which generally produce most severe symptoms, early and sudden in their attack, and rapidly fatal in their results; the chronic, in which the symptoms are not at first urgent, and are more slowly developed, and recovery sometimes occurs without any assistance from treatment and often where there seems no hope of recovery.

Acute conditions of intestinal obstruction comprise :—

(1.) Congenital Strictures or Malformations.

(2.) Foreign bodies impacted in the intestines, and introduced through the stomach, formed in the bowel, or escaping by ulceration from the gall-bladder.

(3.) Twisting or "dislocation" of the bowel, most frequently found in the large, but often in the small intestine.

(4.) Loops, formed by bands of false membrane, adherent at both extremities; by diverticula, adherent by their apices to some portion of the viscera or abdominal wall; or by the fimbriated processes, or other portions of viscera, contracting adhesions, so as to form rings or apertures, entangling the intestine; all these usually the result of peritoneal inflammation.

(5.) Mesenteric pouches; foramen of Winslow; or "thickened peritoneal sheaths," the result of old herniæ.

(6.) Invagination, often caused by worms, intestinal polypi, etc.

Chronic conditions :—

(1.) Constipation, habitual or accidental.

(2.) Inflamed, thickened intestine, the result of injury.

(3.) Chronic peritonitis,—tubercular and abscess.

(4.) Tumours pressing on the bowel,—hydatids, etc.

(5.) Simple stricture of intestine, the result of ulceration and other causes.

(6.) Cancer of the bowel, producing contraction of the gut.

The relative frequency of different causes of obstruction, irrespective of age, is shown in the following tabulated arrangement of 135 cases, collected by Mr. Hinton :—

Diseased uterus		1
Stricture of ileum		1
Cancer of small intestine		2
Internal herniæ:		
Inguinal high up	1	8
Diaphragmatic	2	
Meso-colic	2	
Obturator	3	
Fæcal accumulations		3
Twist of sigmoid flexure		4
Concretions, calculi, and foreign bodies		7
		26

Doubtful	8
Peritoneal adhesions, tubercles, etc.	9
Stricture of sigmoid flexure	10
Ditto colon	11
Ditto rectum	11
Intussusception	24
By bands, adherent diverticula, uterine appendages, etc.	36
In first column	26
Total	135

The *order* of *frequency*, as to different causes of obstruction at various ages, showing the liability of different periods of life, may be thus stated; in regard to youth, middle life, and old age. In *youth;* from internal strangulation by bands of lymph, omentum, or adherent diverticula (Fig. 827), from adhesion of coils of bowel to each other, from intussusception, from foreign bodies taken by the mouth, from cancer rarely, and hitherto found in the rectum only;—in *middle life;* from twists of large or small intestine, from gall-stones, intestinal concretions, and foreign bodies, from intussusception, from simple stricture, from mesenteric hernia, from internal strangulation by bands (Fig. 828), etc., from peritonitis often resulting in abscess, from simple constipation, from cancer;—in *advanced life;* from cancer, from thickened intestine the result of old reducible hernia, from intussusception, from simple stricture, and lastly, from internal strangulation.

Symptoms, and Diagnosis.—Certain symptoms are common to intestinal obstruction arising from any cause. And, whether it be acute or chronic, these symptoms are the same, differing or rather varying only in degree. No definite line of distinction can be drawn between the symptoms in either degree; the acute subsiding into the chronic, and in this state becoming acute in their severity. Hence, the condition, or cause, of obstruction cannot be invariably inferred from the greater or less severity of the symptoms, as the ground of diagnosis. The general symptoms of intestinal obstruction are—pain in the abdomen, and localized more especially in some particular part, with abdominal distension, constipation and vomiting, followed sooner or later by collapse.

Fig. 827.*

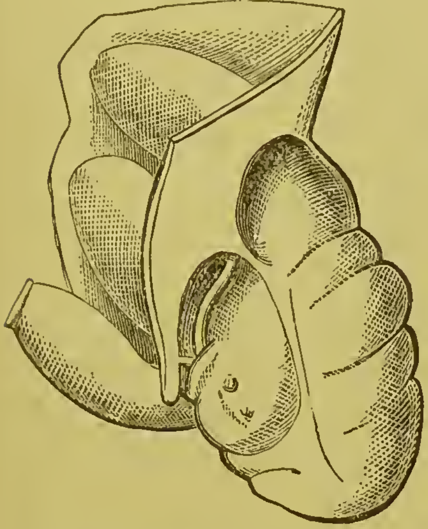


Fig. 828.†

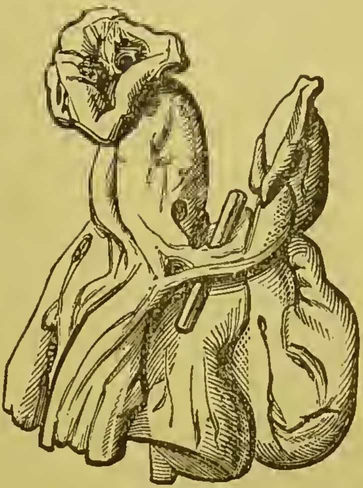
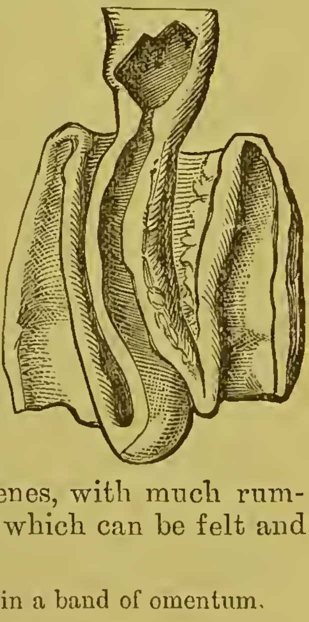


Fig. 829.‡



In *the acute form* of these symptoms, intussusception or invagination of the bowel, at some part of the intestinal canal, as the most common cause of obstruction, will illustrate their usual course. The upper portion of intestine slips into the lower, at the seat of invagination. (Fig. 829.) The patient is seized with abnominal pain, sudden and often acute, which is referred to the seat of injury, perhaps the lower part of the belly; and he seems conscious that something has happened within the abdomen. Flatulent swelling supervenes, with much rumbling and rolling of the intestines; a commotion which can be felt and perhaps seen, and traced up to a part of the canal where it ceases. That is the seat of invagination. A constant desire to relieve the bowels is experienced, and frequent efforts are made to do so; but the constipation is obstinate, and nothing passes, or only a little wind and a lump or two of hardened fæces, or a little mucus mixed with blood may be strained out; not unfrequently, pure blood, fluid or clotted, is discharged. Vomiting soon sets in, the contents of the stomach being ejected, and then speedily stercoraceous matter. This state continuing and increasing, the patient's anxiety and distress are aggravated. His restless endeavours to force a passage by stool, in the vain hope of obtaining relief, the accumulating abdominal distension, and pain heightening to agony, constitute a picture piteous to behold. At length prostration ensues, with some abatement of the symptoms, but of a delusive character; the victim sinks exhausted in a few days, usually in about a week or ten days at the latest. Death is consequent on the exhaustion, coupled with gangrene and peritonitis.

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* St. Thomas's Hosp. Mus., R. 19¹.
† Ibid., R. 14. A portion of small intestine included in a band of omentum.
‡ Ibid., R. 10.

In *chronic* obstruction, stricture of the bowel, and commonly of some portion of the large intestine, as of the sigmoid flexure or of the rectum, is attended with similar symptoms; but they are less speedily developed and less marked. Progressive inability to relieve the bowels, and narrow, constricted, or flattened motions dwindling down at length to constipation, with nausea and then vomiting less early stercoraceous, are succeeded by tympanitic distension and pain. Death may not occur for weeks or months, and recovery takes place when least expected.

The *diagnosis* as to the particular *cause* of obstruction cannot be positively determined by any known special symptoms, except perhaps where the seat of obstruction is low down, near or in the rectum. Nor, with regard to more internal obstructions, is the causative condition so important practically, as its particular *seat*,—the portion of intestinal canal affected. To discover this point, a most careful and thorough examination of the abdomen should be made externally; and an exploration internally as far as possible, through the passages,—the rectum, and the vagina in the case of a female patient.

The diagnostic symptoms in the principal different conditions, acute and chronic, may be thus stated. In *intussusception*, the chief signs are—the fixed pain and the distension, with tenesmus and bloody mucous stools, probably also the detection of an intumescent tumour, and the early age of the patient. In volvulus or *twisting* of the bowel, the abdominal distension may be very unsymmetrical; great tympanitis on one side, and flattening on the other, with the symptoms of internal strangulation. In *internal hernia*, the suddenness and marked severity of the symptoms are somewhat distinctive. In *chronic stricture*, the converse character, and the order, of the symptoms as just described.

Examination per rectum can be made with the finger or by means of a bougie or injection. When the stricture is situated low down, it may be reached with the finger, and a more satisfactory exploration made as to the nature and extent of the constriction. *Simple* stricture is limited usually to a circular band, having a sharp margin around the aperture which communicates with the intestine above. *Cancerous* stricture extends along the rectum, and presents considerable thickening and an irregular or nodulated surface. If a bougie be introduced, it must be passed up with great caution and no degree of force, as frightful damage might be, and has been, done by misadventure. An injection of warm water may be immediately returned or only partially retained, thus plainly declaring the presence of a stricture; especially if the return current should wash away with it any feculent matter, lodged below the obstruction.

Treatment.—The general indication of treatment in intestinal obstruction—from whatever cause arising—is obvious enough; namely, to restore the continuity, and the normal action of the bowel. But how to accomplish this object is always a question of difficulty. Its rational fulfilment would first imply the previous detection of the causative condition in operation,—as to its nature and seat. This precision of diagnosis cannot, as we have seen, generally be attained. So we must be guided by more general rules of treatment.

Medicinal measures have regard to restoring the normal action of the bowel, and allaying the excruciating pain and inflammation, more particularly incident to acute obstruction. With this view, the most important rule is never to administer purgatives; *i.e.*, medicines by the mouth, to force evacuation through the obstructed portion of the intestinal canal. Enemata may generally be used with advantage, oft repeated and copiously, especially if the obstruction is apparently the result of constipation. Mild enemeta are most serviceable, as soap and water, or simply of warm water; their mechanical movement being more effectual than any aperient action. The injection of air or inflation, by means of the stomach-pump, has occasionally proved effectual in overcoming the obstruction, and thus restoring the natural action of the bowel. But I prefer an oleaginous injection, which both distends the intestines, and acts as a solvent of any hard scybalæ or fæcal accumulation. I have thrown in seven pints of olive oil. As the intestinal canal becomes inflated, something is felt to give way suddenly, and a motion soon follows. This practice has been most successful in apparent intussusception, and as occurring in infants and children. Opium is the most efficacious agent for the relief of pain, and it exercises some remedial influence on peritoneal inflammation. But with symptoms of peritonitis, calomel may be combined with opium; and leeches, followed by hot fomentations, should be applied to the abdomen. Solid food, of any kind or in the smallest quantity, must be rigorously prohibited; the patient should be supported entirely by the imbibition of fluid nourishment; and this injunction is scarcely less applicable if the obstruction has yielded, and the bowel lies as yet disorganized or functionally paralyzed.

When medicinal treatment has failed, the question of *operative* interference arises. It is a dire resource, almost as perilous as the condition sought to be removed. Yet it is justifiable as affording the only chance of saving life, in a state otherwise surely fatal. The period of obstruction when such surgical intervention becomes warrantable, cannot be determined absolutely. As a general rule, that laid down by Phillips should be observed; recourse to operation after three or four days have passed, without any relief from ordinary means, constipation being complete and stercoraceous vomiting persistent. Constipation alone will not justify operative interference, unless the obstruction be complete; but with vomiting as a symptom of internal strangulation, an operation is the only alternative between probable life and certain death. Intussusception may be taken as an exception, owing to the pathological condition of the invaginated portion of intestine, with the probability of sloughing and separation of that portion of the bowel. Moreover, the following self-curative results are interesting:—In 24 cases of intussusception, at various periods of life, from two months and a half to fifty years of age, 13 of the patients died unrelieved, some as early as three days, some as late as forty days, from the commencement of the symptoms. But in the other 11 cases, the invaginated pieces of intestine sloughed and were passed by stool. Of these cases, only 2 died soon after the passage of the slough; the remaining 9 entirely recovered. The patients who recovered were ill for periods varying from five to thirty days, and their ages ranged from six to fifty years. Any portion of the intestinal canal may thus undergo spontaneous cure. In 35 cases collected by Dr. W. Thomson, the small intestine was affected in 22 cases; the large, or with the small, in 13. And the length of the invaginated portion of bowel evacuated may have been considerable, varying from six inches to three feet; while in still more rare instances of recovery, a portion of the colon, twenty-nine inches in length, was passed by a child, six years old,—this case being reported by Dr. Dawson, of Ohio; and after the passage of even five feet of intestine, favourable results have occurred in the experience of Dr. Van Buren and Dr. Peaslee.

An operation for the relief of intestinal obstruction will vary in its situation and design according to the seat and nature of the obstruction.

In respect to the *small* intestine, the abdominal wall, and thence the peritoneum, must necessarily be opened, in order to reach the seat of obstruction. Thus may be relieved; obstruction of a hernial character, whether depending on a constricting band, or the gripe of a fissure in the omentum or mesentery through which a coil of intestine has slipped; or a volvulus of the bowel may be untwisted. Least successful will be the operation in the following conditions:—when peritonitis has supervened from prolonged strangulation; in the obstruction from foreign bodies or calculi lodged in the bowel; and in stricture of any portion of the small intestine.

Gastrotomy or *the Abdominal Section* may be performed in the following manner. The arrangements resemble those of ovariotomy in the female. The temperature of the apartment should be raised to about 70° F., and flannels wrung out of warm water be at hand to protect the bowels; the bladder emptied, and chloroform administered. Then the Surgeon, standing conveniently between the legs of the patient recumbent, makes an incision, usually in the middle line below the umbilicus; or elsewhere, over the seat of obstruction, when that can be diagnosed by an intumescent tumour. Proceeding cautiously towards the peritoneum, this membrane is carefully slit up by a probe-pointed bistoury guarded by the forefinger beneath. Any protruding coils of inflated intestine are then to be gently drawn aside by an assistant using the wet flannels, while the operator searches carefully upwards along the empty coils of the bowel until he arrives at the source of obstruction. A constricting band may then be divided cautiously with the scalpel or broken through with the finger; a portion of intestine may be withdrawn from a fissure in the omentum or mesentery, or a twisted portion of bowel may be untwisted. In the event of not thus releasing the bowel in any case, as a last resource, it might be opened as low down as possible, and the aperture stitched to the integument of the abdominal wound, with the hope of establishing an artificial anus. Otherwise, under ordinary circumstances, the bowels should be returned, and the abdominal incision closed by the interrupted wire-suture, supported by a compress and bandage. After-treatment must be conducted on the general principles relating to abdominal wound with peritonitis.

Obstruction of the *large* intestine may be treated by operation through the abdominal wall, in either iliac region, or in either lumbar region.

The design of any such operative procedure is, however, not to overcome the obstruction, commonly a stricture in some portion of the large intestine; but to relieve constipation by forming an artificial anus. Of course, therefore, the bowel must be opened, and above the seat of stricture. Hence, stricture of the rectum or of the sigmoid flexure of the colon will necessitate an opening of the *descending* colon; or in the former case, the *sigmoid flexure* might be opened; and stricture of the descending or of the transverse colon will require a transference of the operation to the *ascending colon*, or to the *cæcum.*

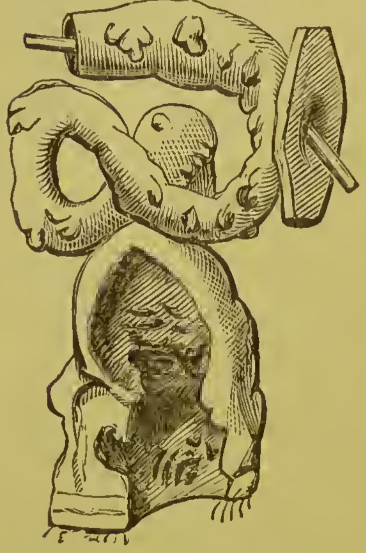
These four sites of operation have, however, different advantages; not as to their respective eligibility for access to the bowel operated on, but with regard to not implicating the peritoneum. In both the operations pertaining to the sigmoid flexure and the cæcum, an opening is made in the iliac region, left or right, whereby in either case the peritoneum must be wounded; whereas, in both the operations on the colon, or by colotomy as it is termed, the bowel is reached in the lumbar region, left or right, and the peritoneum can be avoided.

The *iliac* operation was first suggested by Littre in 1710, who recommended that the sigmoid flexure of the colon might be opened from the left iliac region; but Pillore, a Surgeon of Rouen, first performed the corresponding operation in 1776, by opening the cæcum from the right iliac region. Both these were cases of stricture of the rectum. It may here be added that the *transverse* colon has been opened, in one case, for stricture of the rectum; an operation performed by Fine of Geneva, in 1797.

The *lumbar* operation was proposed by Callisen, in 1796; and he performed it on the descending colon, in the left lumbar region; the subject being the dead body of a child. In seeking the intestine, he accidentally missed the cellular interval uncovered by peritoneum, and wounded this membrane. The operation was thenceforward deemed impracticable, and not attempted on the living body. Amussat revived it in 1839, and extended this procedure to the ascending colon, in the right lumbar region; modifying also the line of incision from a vertical direction, which Callisen had recommended, to a transverse one. Certain advantages are gained by this incision; it makes the operation easier and more certain, and avoids the danger of dividing the lumbar vessels and nerves; it facilitates finding and opening the intestine between the duplicature of peritoneum, without wounding the serous membrane; and it enables the operator to establish the artificial anus more anteriorly.

Colotomy or Amussat's Operation.—The guide to the incision is the interval between the crest of the ilium—its middle third—and the last false rib, and external to the outer margin of the erector spinæ muscle. Commencing just in front of the last-named boundary, an incision is carried forwards transversely, or obliquely from above downwards, corresponding to the middle third of the iliac crest, and to the extent of from four to six inches. Of the two directions of incision, I prefer the latter. The muscular layers of the abdominal wall are then successively divided, and perhaps the external border of the quadratus lumborum muscle. Clearing away the cellulo-adipose tissue, which is sometimes membranous and semi-transparent, looking like the peritoneum, the colon presents itself, and the more so if loaded; it appears at the bottom of the wound, and free of peritoneum. It is recognized by its muscular character, somewhat greenish colour, and distended sacculated appearance; and the more fully the gut is engorged, the more freely will it have uncovered itself through the duplicature of the peritoneum—the meso-colon. The gut should be hooked up with a tenaculum, avoiding the peritoneum on either side, and drawn well out to the integument, to prevent any feculent effusion into the cellular texture, as the gut gradually collapses by discharging its contents when opened. A small aperture is then made with the scalpel, and there usually takes place a gush and copious flow of feculent fluid. Basins should be at hand to receive the abundant evacuation. The margin of the opening in the colon is then secured to the integumental incision, by means of a few points of suture; so that an artificial anus thus formed may become established. (Fig. 830.) Before this operation, should the colon not be distended by the retention of feculent matter, it will be desirable to inflate the gut by injection with warm water, that it may appear more prominently in the lumbar incision. After-treatment consists in combating collapse and peritonitis. Opium and support are the principal constitutional requirements; and scrupulous cleanliness is the most urgent local observance to be attended to. The constant discharge of fæces through the wound may generally be controlled by the use of an ivory ball, fitting the aperture in the bowel, and attached to a small shield, over which a soft thin piece of india-rubber should be fastened; the whole contrivance being retained in position by a bandage.

Fig. 830.*



This operation has now been resorted to by many Surgeons, myself included. Its results may be gathered from the analysis of 44 cases, in which an artificial anus has been formed by opening the large intestine. From a paper by Mr. Cæsar Hawkins, published in the "Med.-Chir. Transactions," vol. xxv., it appears that of these 44 cases, in 17 the anal opening was made through the peritoneum, and in 26 behind that membrane; but as 5 of the peritoneal sections were exceptional cases, 12 only are left to compare with 26 cases of operation behind the peritoneum. Of the former, 7 died and 5 recovered,—the recoveries amounting, therefore, to only 41 per cent.; whereas, of the 26 cases of unopened peritoneum, 10 died and 16 recovered,—the proportion of recoveries amounting to 61 per cent. In all these cases, the large intestine was the seat of operation; it was performed on the *right* side in 10 instances; in 4, the right colon and cæcum were opened through the peritoneum, and all of these cases were fatal; whilst of the remaining 6, in which the right colon was opened behind the peritoneum, 4 recovered. The advantage, therefore, on the right side, is in favour of the *lumbar*, or Amussat's operation. On the *left* side, however, the results are less favourable. Of 8 cases in which the left colon was opened through the peritoneum, 5 recovered and 3 died; whilst of 20 cases in which the *lumbar* operation was performed, 11 recovered, but 9 were fatal.

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* St. Thomas's Hosp. Mus., Q. 157^2. Cancerous stricture of descending colon, with colotomy resulting in artificial anus.

Respecting then any operation for the formation of artificial anus in intestinal obstruction, affecting the large intestine, these results well deserve serious consideration.

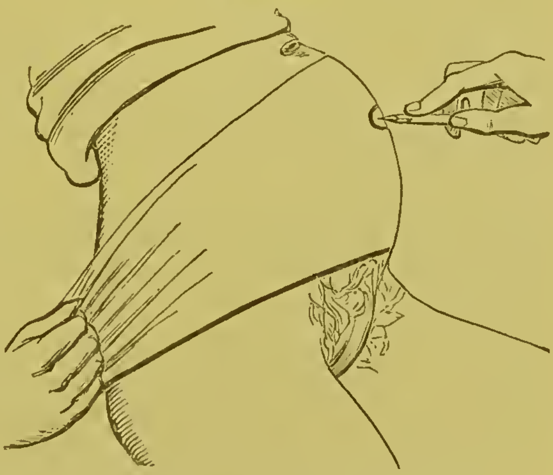
CHAPTER LIX.

PARACENTESIS ABDOMINIS.

In dropsy of the abdomen, whether ascites or ovarian, the peritoneal sac, or an ovarian cyst, becomes distended with fluid; and either cavity may be emptied of its contents by *Tapping*.

This is a very simple operation. The bladder having been emptied, the patient should be seated on the edge of a chair, or, if very weak, turned sideways to the edge of the bed; so that in either position the protuberant belly shall be exposed. A flannel roller, or a jack-towel, the breadth of the abdomen from above downwards, is then passed round, and the ends, crossing behind the loins, are given in charge of an assistant on either side. They should draw the roller equably, to compress the abdomen uniformly, as the water flows. A small aperture is cut in the roller, corresponding to the point where the abdominal puncture is about to be made; namely, in the middle line, about two or three inches below the umbilicus. The Surgeon seating himself before the patient, as placed in the sitting posture, he makes a small vertical incision at the spot indicated, and through the integumental wound thus made, a large-sized trocar and cannula is thrust into the abdomen. (Fig. 831.) Or the thrust may be made at once, without any preparatory incision, the skin yielding without any appreciable

Fig. 831.



damage to this texture. On withdrawing the trocar, taking care that the cannula do not slip out after it, the fluid spouts out in a full stream, and is received into a pail below. A convenient and more elegant arrangement is the adaptation to the cannula of a tube of india-rubber, provided with a stop-cock. The kind of fluid varies in colour and thickness; in ovarian dropsy, it is commonly of a brownish coffee-colour, turbid, and thick or of almost glutinous consistence between the thumb and finger, and it froths up as the stream continues. The assistants should draw the roller firmly, and especially as the stream weakens and dribbles, when air might pass back into the peritoneal cavity. Towards the last, the fluid may be tinged with blood, owing apparently to the mouth of the cannula impinging on the visceral layer of peritoneum. Then, unless by further traction the stream can be resumed, the cannula should be withdrawn.

The patient may become faint, as the fluid-pressure on the abdominal vessels diminishes; when a little brandy-and-water or wine may be administered, and the orifice of the cannula stopped with the finger for a while. Sometimes the fluid suddenly ceases to flow, a bit of intestine coming in contact with the end of the cannula, or the tube being blocked up; in either case, the obstruction may be removed by introducing a piece of bougie or other blunt-pointed tube.

On withdrawing the cannula, a small strip of adhesive plaster will suffice to close the abdominal aperture. A broad flannel bandage should, however, be well applied round the abdomen to maintain compression; thus preventing faintness, and the reaccumulation of fluid or recurrence of dropsy.

This operation may be modified according to circumstances; any other convenient situation may be chosen for the puncture, provided that there be no tympanitic resonance to indicate the presence of intestine, but the dulness on percussion of a fluid collection; and the course of the epigastric vessels must also be avoided. The intestine—a portion of jejunum—has been wounded, and yet the patient recovered. This accident occurred in a case communicated by Mr. Gay to the Pathological Society, which is recorded in the second volume of the Society's "Transactions."

Tapping during *pregnancy* is an operative procedure the propriety of which would appear to be questionable. But although sometimes followed by the premature birth of the child, it has in many instances been practised, even at the seventh or eighth month, without inducing miscarriage.

Accidental hæmorrhage happens occasionally in the operation of tapping the abdomen; arterial blood escapes through the cannula on being withdrawn beyond the abdominal cavity, or the patient turns faint subsequently from internal hæmorrhage. This arises, apparently, from a punctured wound of the epigastric artery. Four or five such cases were collected by South in Chelius's Surgery, and one instance is recorded by Hamilton in his treatise on Military Surgery. The source of hæmorrhage may, perhaps, be controlled by pressure; either by the introduction of a gum elastic bougie as a plug, or by means of a graduated compress over the cannula-aperture, or by compression, if the abdominal wall be loose and can be raised up in a fold. The artery might be ligatured or twisted, by an incision to reach the vessel; but this would not be a very easy or safe procedure.

CHAPTER LX.

DISEASES, INJURIES, AND MALFORMATIONS OF THE RECTUM AND ANUS.

Diseases of the Rectum and Anus pertain to the terminal portion of the large intestine, in its limited course of six or eight inches from the left sacro-iliac articulation to the anal orifice in the perineum.

Surgically considered, the rectum might almost be said to have a more limited extent,—in regard to its liability to disease. At its commencement, the bowel inclines downwards and inwards to the middle of the sacrum; thence it curves forwards in front of this bone and the coccyx,—behind the bladder, vesiculæ seminales, and prostate, in the male, or the cervix uteri and vagina, in the female; and opposite the tip of the coccyx, or the prostate anteriorly, it inclines downwards and backwards to the anus,—leaving an interval between this portion of the bowel and the membranous part of the urethra and its bulb. It is in these two latter portions of the gut, or in about the lower half of its whole extent, that most rectal affections are congregated; and they derive some additional importance from the relative position of the bladder and prostate gland.

Diseases thus crowded together, may be most conveniently arranged according to their pathological association and diagnosis, observing also their order of frequency in the practice of this branch of Surgery. Affections of the rectal tube and of its anal aperture will, therefore, be considered as follows:—Inflammation and Rectal Abscess; Fistula in Ano; Ulcer of the Rectum, and Fissure of the Anus; Hæmorrhoids—external, internal, and Prolapsus of the Rectum; Polypus of the Rectum; Stricture of the Rectum—Simple, Cancerous; Rectal Fistula,—Vesical, Vaginal; Anal Tumours; Anal Contraction; Injuries; Foreign Bodies; Congenital Malformations; Functional Disorders.

Inflammation and Rectal Abscess.—In the loose cellular texture around the rectum, and particularly in that of the ischio-rectal fossa on either side of the anus, inflammation is very apt to occur, and speedily pass into suppuration. According to the situation of the abscess thus formed, it is more or less deep-seated or superficial; but in either case, the matter has a tendency to burrow upwards in the direction of least restraint,—the pelvic cellular tissue leading from the ischio-rectal fossa, beneath the levator ani muscle, rather than towards the thick and unyielding integument continued from the buttock over the fossa.

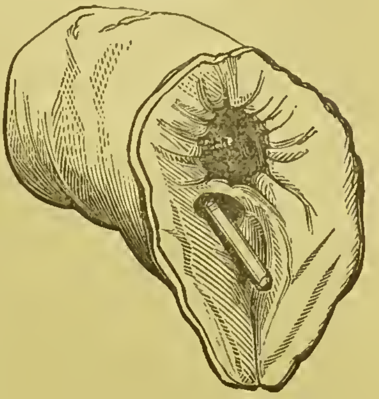
The *symptoms* of rectal abscess are, not unfrequently, indistinct. Pain is felt in the fundament, more especially on passing a motion, and if the fæces be hard and irritating. The pain has the usual throbbing character when matter forms; though sometimes this takes place without scarcely any sensation, but that of a dull aching weight as matter accumulates. Hence, two varieties of abscess may be recognized,—the *acute* and the *chronic*. In both, there will be some tenderness on pressure, on one side of the anus; swelling also sooner or later becomes apparent, which is hard and brawny, though perhaps softer at one point. On passing the finger up the bowel, this painful swelling may be felt before it reaches the perineal surface. In connection with these local signs, other symptoms may be present; a constant bearing down and desire to relieve the bowel, yet, with straining efforts, only a little mucus passes; or there may be obstruction to the evacuation of fæces, and constipation; while a troublesome irritability of the urinary bladder and frequent micturition is experienced, or a difficulty in passing water and even retention of urine. The situation of *pointing* is various, and specially important. Rectal abscess coming to the surface, points slowly in the perineum by the side of the anus; occasionally, however, at some distance from the bowel,—in the middle of the thigh, or backwards, near the trochanter; but, not unfrequently, it opens into the bowel, and perhaps also externally in the perineum. Fistula in ano results when any opening of a rectal abscess becomes established in the neighbourhood of the anus; and the varieties of fistula thus formed will be noticed presently. The matter discharged from an abscess adjoining the rectum has always a fæcal odour; more perceptible if there be a communication with the bowel, although it is distinctly fæcal in any case, owing probably to transudation.

Causes.—Various local causes give rise to this abscess; any source of irritation, as habitual rectal constipation, or a foreign body in the bowel, as a fish-bone, which Liston found, the core of an apple, which Brodie detected, or a piece of tooth; occasionally, caries of an adjacent bone, as of the coccyx or sacrum, or of the tuberosity of the ischium in one of my own cases; or disease of the bowel itself may be the cause in operation; lastly, some external injury, as a kick or contusion, may have induced inflammation; or exposure to cold, as by sitting on a cold stone, has brought about congestion followed by suppuration. Chronic rectal abscess not unfrequently results from obstruction to the venous circulation, and is symptomatic of some organic disease of the lungs, liver, or heart. Often, as chronic abscess coexisting with a phthisical tendency or actual phthisis, the local disease is of constitutional origin. Whenever dependent on venons obstruction, congestion of the hæmorrhoidal veins, or piles, is commonly associated.

Treatment.—In an early stage, before suppuration has occurred, resolution can sometimes be effected. Laxative aperients rather than purgatives, and careful regulation of the diet, with warm fomentations, may succeed in dispersing the inflammation. If not thus serviceable, these measures will prepare the way for the better management of suppuration. An early opening should be made to prevent the matter burrowing around the gut. As soon, therefore, as the formation of matter can be detected or suspected, although fluctuation be very indistinct, and certainly before any pointing has appeared, the forefinger, well greased, may be passed into the bowel, and the thumb placed below the swelling externally, thus taking the abscess between the finger and thumb, so as to render it tense and defined; a sharp-pointed bistoury should be entered carefully by the side of the bowel, and if a drop of pus rises up by the side of the blade, the opening must be sufficiently enlarged downwards to let out the matter already accumulated and allow a free discharge subsequently. A strip of lint is then inserted. The abscess having been laid open, it usually heals from the bottom, without communicating with the bowel or leaving an external fistula.

Fistula in Ano.—Any pus-secreting tract which passes up by the side of the anus is designated, from its proximity, a fistula in ano. It results from the contraction and partial closure of an ischio-rectal abscess, leaving only this narrow channel. Commonly, it opens both internally, into the bowel, and externally in the vicinity of the anus; sometimes, there is but one orifice,—an external, or an internal. Corresponding conditions of fistula may, therefore, be recognized.

Fig. 832.*



Complete fistula has two openings; one into the bowel, another on the surface of the skin. (Fig. 832.) *Incomplete* or blind fistula has but one opening; an external opening on the skin, but no communication with the bowel,—constituting *blind external* fistula; or there may be an internal opening into the bowel, but no opening on the skin,—forming *blind internal* fistula.

These fistulous openings have some features worthy of notice. The *integumental* orifice is situated usually over the fossa by the side of the anus; but it may be removed to some distance outwards and posteriorly at the back of the buttock, and towards the great trochanter. In point of size, the orifice is smaller or larger, admitting only a probe or a director easily; it has a puffed, everted appearance, with perhaps protuberant granulations indisposed to close, and moist with a constantly oozing, fetid, purulent discharge. Sometimes, there is more than one fistulous opening, even several, resembling a water-pot spout, and all discharging matter. These orifices are scattered in various directions near the anus; and lead by very tortuous, devious routes to the abscess, and thence to the bowel; branch sinuses, perhaps, passing off from these fistulous tracts. On either side of the gut, also, one or more fistulous openings may have formed. Occasionally, an external opening on either side leads to a fistula which runs round the bowel, usually backwards, and there communicates with the gut by a single orifice; or an external and an internal opening may be found on opposite sides, the fistulous passage running round the bowel; thus in either way forming a *horseshoe* fistula. The *rectal* orifice varies chiefly in its height up the bowel. Commonly, it is situated just above the sphincter ani, where the rectum enlarges, especially in old people and females; this opening is, however, not the termination of the fistula, which usually runs up further outside the bowel into the cul-de-sac. It has been affirmed by some of the best authorities, that the inner orifice of fistula in ano is never higher up in the bowel than about the spot referred to. Mr. Ribes in 1820, and previously, I believe, Sabatier, held this opinion; it was supported by Sir B. Brodie and Mr. Syme, and the special observations of Dr. Bushe, of New York, tend to the same conclusion. On the other hand, Mr. Curling disproves this conclusion, and although Mr. Quain does not take up the question in his clinical lectures on Diseases of the Rectum, yet the facts there stated are equally opposed. In Case 29 of these lectures, the inner opening was situated more than two inches up the rectum, and equally high up in Case 32. I may add, that in a case of complete fistula, on which I operated, the inner orifice was three inches from the anus.

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* St. Thomas's Hosp. Mus., Q. 164. Fistula in ano, with the sphincter ani muscle across the passage.

The *diagnosis* of the three conditions of fistula in ano is very obvious. Complete and blind external fistula both present an external opening by the side of the anus, or otherwise placed. But on passing up a probe or director along the course of the fistula to the bowel, the forefinger of the other hand having been introduced into the gut to feel for the point of the instrument; in the one condition of fistula, an opening is discovered through which the probe can be made to touch the finger,—no septum intervening; in the other condition, the point of the probe will be felt more or less plainly through the thickness of the bowel, but not in contact with the finger,—a membranous septum, however thin, always intervening. Blind internal fistula is less readily detected. There may be some brawny swelling and tenderness on pressure externally, with perhaps a burning pain after defecation, owing to the lodgment of feculent matter in the fistula; but there is no external opening. A purulent discharge from the interior of the bowel, and the escape of pus on pressure over the ischio-rectal fossa, will both lead to the diagnosis of an internal fistula; and this will be confirmed by feeling the orifice in the gut, when the finger is passed into the anus. The horseshoe form of fistula presents some induration on both sides of the anus, as distinctive of the peculiar course of the passage.

The relation of fistula in ano to rectal abscess has been disputed. Abscess is said to occur first, external to the bowel; then opening into it, and outwards, by the side of the anus, a complete fistula is thus constituted. If the abscess opens only externally, a blind external fistula results. This mode of fistula formation I have already alluded to, and it is that which Mr. Syme maintains. Conversely, ulceration of the mucous membrane of the bowel is a reputed mode of origin; and leading to the formation of an opening, and an abscess externally,—a blind internal fistula is thus produced, which may result in complete fistula. This was the opinion held by Sir B. Brodie. In the one mode of formation, abscess precedes and causes—in the other, it follows and results from—the formation of an opening in the gut. Doubtless, fistula originates in both ways. Blind external fistula—not an uncommon condition—must necessarily arise by an abscess independent of the rectum, there being no communication with the bowel. The particular way in which fistula arises is determined, probably, by the causes of rectal abscess. Any occasion of irritation or of venous congestion, external to the bowel, will probably produce abscess in that situation, followed by fistula; any impaction of fæces or a foreign body in the rectum will probably produce ulceration of the mucous membrane, followed by some amount of feculent extravasation into the surrounding cellular texture, and abcess as the result of this irritation.

The *prognosis* is unfavourable in proportion to the organic or constitutional origin of the disease; as in fistula arising from venous congestion, and dependent on some organic disease of the heart, liver, or lungs,—especially phthisis.

Treatment.—*Spontaneous* cure may possibly take place, when the fistula is of short extent, without induration, and situated at some distance from the anus, away from the action of the sphincter muscle;

the fistulous passage contracts and closes up, and either or both orifices, as the case may be. Rarely, however, is any such curvative tendency evinced; and while the Surgeon might be misled by exceptional instances of this kind, patients are too often deluded and their sufferings prolonged by the specious promises of rapacious quacks, with their dressings, or other "peculiar treatment, without the use of the knife."

An *operation* is usually the only means of cure. Such interference is contra-indicated whenever fistula depends on some persistent cause. Operation would then be either useless or prejudicial,—it would fail to cure the disease, or, being thus successful, it would develop the causative condition into greater activity. Therefore, operative interference, for the cure of fistula, should not be had recourse to in fistula connected with any persistent local condition, as disease of the rectum, or caries of the sacrum or coccyx; and still less, when it is dependent on some constitutional condition, advanced phthisis in particular. In this disease, the drain by constant discharge from the fistula might seem to aid in reducing the general health; but its derivative influence on the pulmonary disease is a more important consideration, and also that the operation-wound will probably not heal. But at an earlier period, and when the disease is not rapidly progressing, coupled with favourable hygienic circumstances, experience inclines to the constitutional advantage of operation, and the probability of cure.

No principle of treatment is more simple than that of the established operation for fistula in ano; and no operative procedure is generally more easily performed, or is more effectual. The principle is simply this,—that the fistula being kept open by the almost constant action of the adjoining sphincter ani muscle, division of this muscle will set the part at rest, and allow it to heal and close from the bottom. Accordingly, the bowels having been well cleared with castor oil or other mild aperient medicine, and the rectum emptied by an enema on the day of operation, the patient is laid on the side most convenient to the operator; the thighs are drawn up so that the buttocks shall project over the side of the bed or table, and the latter held apart by an assistant. A probe, or director, introduced through the external opening in the skin, will guide to the internal opening, should it exist, or to a spot

FIG. 833.*

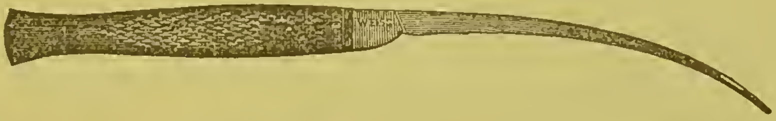
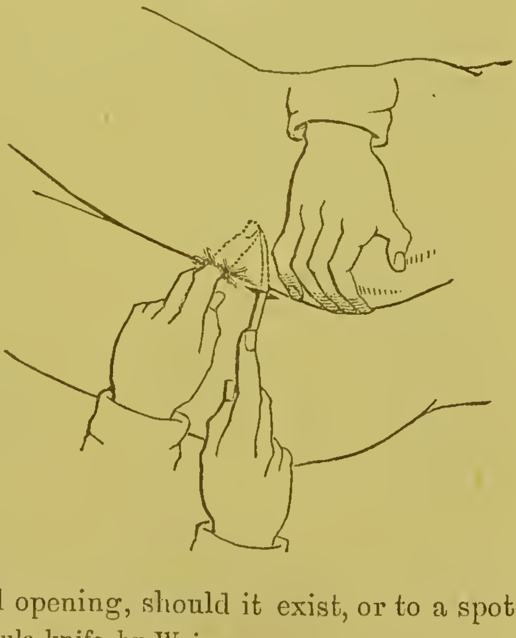


FIG. 834.



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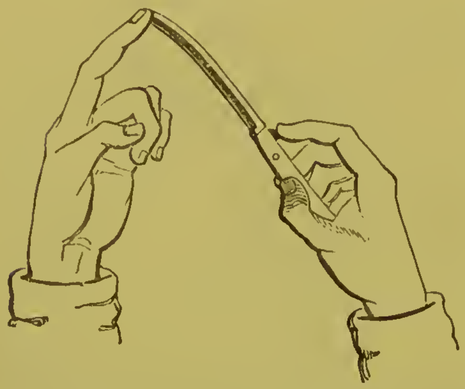
* Curling's fistula-knife, by Weiss.

where the bowel is thin and about to give way. At the same time, the forefinger of the other hand is introduced into the rectum until it rests upon or feels the point of the director, which is then held by the assistant with the other hand. A curved, narrow-bladed bistoury, blunt-pointed or sharp-pointed (Fig. 833), according as the fistula is complete or incomplete, is slid through the external orifice of the fistula, along the groove of the director, until it touches the point of the finger in the rectum (Fig. 834); when the fistulous tract is laid open freely into the bowel—the knife dividing at one sweep the skin, sphincter, and bowel, and coming out of the anal aperture, with its point still resting on, and protected by, the point of the finger. It will be observed that the cul-de-sac, above the opening of the bowel, is left undivided in the operation as thus described. Its division is unnecessary, to fulfil the principle of the operation, and might implicate branches of the middle hæmorrhoidal artery, producing serious hæmorrhage. This terminal portion of the fistula generally closes, with the open tract, now that the sphincter ani is divided and set at rest. If one or more branch sinuses exist, they also may be laid open. An indurated fistula may be slow to heal, even when laid open; it will be advisable, therefore, to reverse the knife, and draw the blade through the tract into the sound textures, tailing off this incision beyond the external orifice,—as the "back-cut" practised by Salmon. The surrounding hardness then soon disappears, and the wound granulates readily from the bottom, as I have often noticed in my own practice.

Complete fistula, and blind external fistula, are thus operated on. Blind internal fistula presents no external orifice; a bent probe must, therefore, be passed up through the anus, and diverted into the rectal opening, thence downwards to the integument. When its point is plainly felt projecting, a puncture should be made with a sharp-pointed bistoury, and the operation completed in the usual manner. For horseshoe-shaped fistula, a one-sided operation would prove ineffectual; the fistulous passage must be slit up throughout its course, from one side of the bowel to the other, and the sphincter divided through the opening.

In performing the operation for fistula in ano with the ordinary bistoury, two accidents are liable to happen, as contingent on the construction of the instrument—an unprotected knife. Its *sharp* edge—so keen, as Pott observes—may pass out of the fistulous tract; or the point, necessarily *sharp*, in the absence of an inner opening, may pass out, instead of penetrating the bowel. Both these accidents are apt to occur in the act of sliding the knife through the fistula; particularly if the tract be long, narrow, and tortuous; while misdirection of the point may take place, more especially in blind external fistula. Moreover, there is the difficulty occasioned by the additional thickness of the director in the fistulous tract, whenever this instrument is also indispensable—*i.e.*, in precisely the above-named conditions. To obviate

Fig. 835.



any risk of either of these two misadventures, and of the mechanical embarrassment, I, some years ago, invented a knife, which has an ensheathed blade, and is hence denominated the "concealed fistula-knife." (Fig. 835.) It has the appearance of an ordinary director, set in the handle of a scalpel. *This* director is introduced through the fistula into the bowel, when, by depressing a button on the back of the handle, the instrument is *then* converted into a knife, having a sharp point, which can be passed through the bowel, if the fistula be incomplete; and the operation finished in the ordinary manner. One instrument, therefore, suffices to begin and complete the operation, and by a more simple, speedy, and safe procedure. I have operated with this concealed knife many times, and under circumstances of some difficulty; always with ease, and with an in-and-out-again movement, not otherwise practicable.

In concluding the operation, a narrow strip of oiled lint should be passed up the bowel, into the cul-de-sac when it exists, and laid within the wound of the open fistulous tract. Thus healing and closure by granulation may take place from the bottom. But it will be unnecessary and undesirable to continue this lint-tent longer than the first two or three days. If its application be unduly prolonged, the wound may become a chronic granular cleft, indisposed to contract and cicatrize; or it heals, leaving a gap, and a weakened state of the sphincter muscle with a tendency to the involuntary escape of fæces and flatus. This latter state I have known to remain for five or six years, or even permanently, after the operation; and it is perhaps unavoidable to some extent in the after-management of an operation, when the fistula itself was deep, chronic, or both. The discomfort and misery entailed by the perpetual liability to feculent discharge, may be almost worse than the original fistula; usually, however, the sphincter gradually regains its strength and the power of retention is restored. But I know of no operative resource for substituting an efficient contraction of the anal aperture.

After-treatment.—The bowels having been thoroughly emptied before operation, no action may take place for two or three days; any liability to disturbance must be restrained by opium, and then the gentlest aperient—castor oil—should be administered. Hæmorrhage rarely proves troublesome. At the time of operation occasionally, bleeding may be such as evidently to require special means to arrest it; the wound should be plugged with lint to the bottom, and a compress applied, secured by a T bandage. Then the patient should be watched, lest hæmorrhage continuing internally, and the blood passing up the bowel, a large quantity might be lost imperceptibly. Secondary hæmorrhage, occurring in the course of a few hours, must be treated in like manner; the clots removed, ice-cold water injected, and a plug introduced well up the bowel. The wound heals usually in two or three weeks. If sluggish and indisposed to close, the healing process seems to be assisted by the administration of the confectio piperis nigri, in drachm doses, at bed-time.

Ligature of the septal portion of bowel has sometimes proved successful. This operation has of late years been strongly advocated by Mr. Luke. A horsehair or flexible wire ligature is passed, by means of an eyed-probe, through the fistula into the bowel; the two ends are tied, and adapted to a small screw. The ligature is tightened, as it ulcerates its way through the septum; in a week or two it becomes detached, the fissure at the same time granulating from the bottom. One advantage attends this method of dividing the fistula—hæmorrhage is less likely to occur. Ligature may, therefore, be more appropriate than cutting with the knife, in deep fistula; where that operation might implicate the middle hæmorrhoidal artery. But in long, narrow, and tortuous fistula, the introduction of a ligature will scarcely be practicable; and in any case, this method of cure is tedious and painful.

Stimulant application to the fistulous tract is also another mode of cure, by inducing contraction and closure. This, however, is limited to blind external fistula, of short extent, free from induration, and situated perhaps at some distance from the anus, removed from the action of the sphincter muscle—the very conditions which are conducive sometimes to spontaneous cure. Such application may be made, either by means of irritant injections, as tincture of cantharides or tincture of iodine, used daily; or by passing up a probe armed with fused nitrate of silver. In the course of this treatment, the general health must also be improved by medicinal and hygienic measures.

The *results* of treatment, whether by ligature or by stimulant injection, have not been very encouraging. Mr. Allingham has had ten successful cases, principally by injection; but in more than twice that number, after a prolonged attempt, the results were unsuccessful. The failure thus to effect a cure contrasts with the general experience of the cutting operation usually practised.

Double fistula in ano requires a double operation, if the fistula be complete on both sides; and both may be advantageously slit up at the same time. Branch *sinuses*, with only one internal orifice, must be laid open; but the operation should be completed only through the primary sinus, where the inner orifice exists, leaving the bowel untouched elsewhere.

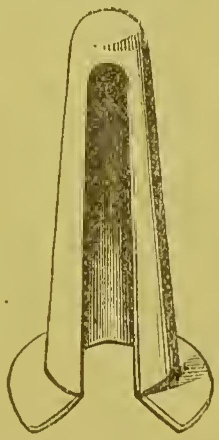
ULCER OF THE RECTUM, AND FISSURE OF THE ANUS.—These two conditions may exist separately, or coexist. *Ulcer* of the rectum is situated just within the sphincter ani, and usually at the posterior part, near the coccyx; occasionally, however, having a lateral, or a perineal position. Extending outwards, perhaps, to the anal aperture, it is commonly associated with a small external hæmorrhoid or pile, beneath the base of which the terminal limit of the ulcer lies concealed. Thus defined, the ulcer is situated partly within the rectum, just above the ring of the sphincter muscle; and partly within the circumference of the anal aperture, approaching the condition of fissured anus. The ulcer is quite superficial, and varies in size from a large pin's head to a large split pea; when distended, it has an ovoid or circular shape; its surface is smooth, or rough when relaxed, and the colour may be reddish or sloughy ash-grey, with a slightly indurated margin. It lies, almost concealed, between the longitudinal folds of the rectal mucous membrane, the edges of the sore appearing only as a small fissure in the direction of the bowel; but on distending this passage with the speculum, the ulcer is brought into view, and its characters may be recognized.

Fissure of the anus is situated at the anal aperture—the junction of the mucous membrane and integument, and not involving the rectum; but, like rectal ulcer, usually having a dorsal position. It consists of a crack or streak of excoriation, running lengthways between the loose folds of mucous membrane and integument which surround the anus. The ulcer is not more than half an inch long, and a line in breadth, of an ovoid or club shape, the floor having a red or grey colour, and its margins are indurated and well defined. An overhanging pile is often associated with fissure; and, according to Mr. Allingham's observations, a gelatinous or fibrous polypus is a not uncommon complication; the polypus being situated usually at the upper or internal end of the fissure, but perhaps on the opposite side of the bowel. Two or more fissures also not unfrequently coexist.

The *Symptoms* of these ulcerative affections are easily recognized. Both states are acutely painful, out of all proportion to the limited extent of structural lesion, and the constantly recurring suffering gives a remarkably haggard and pallid expression of countenance; both states also, especially rectal ulcer, are attended with more or less spasmodic contraction of the sphincter,—like that of an india-rubber band, having a sharp upper margin, and with some irritability of the urinary bladder, a tendency to spasmodic stricture and seminal emissions. *Spasm* of the sphincter has been regarded as a peculiar and independent affection —such is the opinion of Copeland and Syme; it is more probably, as Mr. Quain alleges, secondary and sympathetic.

Proceeding to *diagnosis*:—with ulcer of the rectum, sometimes distinguished as "painful" and "irritable" ulcer, there is most acute burning pain in passing a motion; the suffering increases after the act, and continues for a considerable period, varying from a quarter of an hour to several hours, and then subsiding into ease until the bowels are again moved. With fissure of the anus, there is smarting or even equal pain, as a motion passes; but it subsides within a few minutes, when the temporary irritation has ceased, and the more readily if the part be sponged and cleansed properly after the act. Then, again, some amount of bloody purulent discharge may be observed in both ulcerative affections; but in that of the rectum, there is no external appearance of ulceration, unless the part be protruded and carefully examined; yet the ulcer can be felt and seen. On introducing the finger just *within* the anus, and generally towards the coccyx, a small depressed surface can be detected; touching this spot causes sharp, burning pain, and provokes a more powerful spasmodic contraction of the sphincter around the end of the finger. By examining the rectum with the speculum ani (Fig. 836), the ulcer may be brought into view through the open side of the tube. To facilitate either method of examination, in this and all other painful affections of the interior of the rectum, the influence of chloroform is an invaluable boon both to the patient and the Surgeon. In fissure of the anus, the ulcer-crack can be discovered by a little careful search *externally*.

FIG. 836.



The *causes* of these ulcerative affections would seem to be; rectal constipation, in the production of ulcer within the bowel, and this may be aided by violent straining defæcation; while the external fissure is probably induced by want of cleanliness, as by gonorrhœal matter coming in contact with the thin sensitive skin around the anus, or by that syphilitic discharge which begets mucous tubercles. Females, therefore, are most liable to such anal ulceration; owing to the proximity of the vaginal discharge, and the easily cracking nature of their perineal and anal integument. But not unfrequently either form of ulceration is connected with uterine displacements. Middle age is most subject to these affections. A sedentary occupation predisposes to fissure.

Treatment.—In *recent* ulceration and of *slight extent*, a cure may sometimes be effected by stimulant applications, with anodyne suppositories to allay pain; the bowels being well regulated by castor oil, or other gentle aperient, and scrupulous attention to cleanliness observed after any action of the bowels, or as to any other source of irritation. Accordingly, the ulcerated spot may be touched occasionally with stick nitrate of silver or a piece of sulphate of copper; and in fissured anus, the caustic must be run along within the crack so as to fairly touch the bottom of the angle. A weak lotion of sulphate of copper or zinc, acetate of lead, or the black mercurial wash, may also be sponged up, two or three times a day. An anodyne and astringent suppository is highly recommended by Mr. Erichsen, as very efficacious in this and many other painful affections of the anus. It consists of two grains of extract of belladonna, two grains of the acetate of lead, and four of tannin, made up to a proper consistence with a little suet. This should be passed into the rectum every night and allowed to dissolve there. I have found nothing so soothing, and apparently protective to the ulcer, as a suppository of simply pil. sapon. co., gr. x. The beneficial effect of these topical applications is to be estimated by the mitigation of pain, and by the ulcerated surface assuming a healthy, reddish, granulating appearance, and contracting.

In *old-standing* and more *extensive* ulceration, operative interference is the only cure. The old precedure, originated by Boyer, was division of the sphincter ani, so as to set this muscle at rest, as by the operation for fistula in ano. Copeland proved that this deep cut is quite unnecessary; and that the more superficial incision, limited only to the mucous membrane, through the whole length of the sore, is equally curative. This section of the mucous membrane alone has since been advocated by Brodie, Syme, and Quain; and it is now the established operation for the cure of ulcer of the rectum and fissure of the anus. The superficial muscular fibres of the sphincter must, however, necessarily be cut, when the ulcer has destroyed the whole thickness of the mucous membrane. Mr. Curling once noticed the fibres of the sphincter at the base of the sore, in which case they would be divided by any incision through the sore. Mr. Allingham's experience leads him to practise a somewhat deeper incision, not less than to the depth of a quarter of an inch, sufficient to secure the relaxation of the sphincter, and set the part entirely at rest; without, however, cutting as deep as in the old operation.

The operation is easily done, when the anus is thoroughly opened by an assistant. The forefinger is introduced into the rectum, opposite the sore, and a probe-pointed bistoury slipped up sideways, and planted just above the ulcer or fissure; the blade is then drawn downwards and outwards steadily along the centre of the sore or in the fissure, dividing the mucous membrane—the depth being about the eighth of an inch. This incision may advantageously extend into the sound texture, a little above and below the upper and lower end of the ulcer or fissure. A thin strip of oiled lint should be laid in the wound and retained for a day or two. An overhanging external pile may be snipped off with scissors; or a mucous or fibrous polypus, within the bowel, should be removed in like manner. Double fissure must be operated on in the same way as a single crack.

The only preparation for this simple proceeding is thorough evacuation of the bowels beforehand; and the only after-treatment requisite is an opiate, to lessen pain and prevent any action of the bowels, followed by a dose of castor oil in two or three days. The relief afforded by section of the mucous membrane is almost instantaneous, and the patient feeding well, daily regains health and spirits. In the course of two or three weeks, the wound will probably have healed. A slow-healing wound may be advantageously touched with nitrate of silver, and the administration of the confection of black pepper has apparently a beneficial influence. The result of this superficial operation is usually a permanent cure, and with no evil consequences; whereas deep section or division of the sphincter ani muscle is sometimes followed by loss of retentive power and involuntary defæcation. I have known a patient, in this condition after operation, pass a motion on coming into the consulting-room; the contents of the bowel slipping away from him in the mere act of walking or standing.

Ulceration of the Rectum may be met with above the internal sphincter, extending up the bowel to three or four inches, or even involving the sigmoid flexure of the colon. The mucous membrane is removed in parts, exposing the muscular coat in the form of deep patches of ulceration; perhaps the intermediate portions of mucous membrane become detached, leaving only bridges or mere bridles between the ulcers; and, these remnants at length disappearing, the interior of the bowel is laid bare to a variable extent. In point of depth, the ulceration may be accompanied with thickening of the submucous tissue, or hypertrophy of the muscular coat, resulting in contraction or stricture of the bowel; but, not unfrequently, perforation takes place with fatal extravasation of feculent matter; or if this result be prevented by adhesive peritonitis of the intestine or omentum, abscesses form around the bowel, and open externally by fistulous passages.

The *symptoms* of this rectal ulceration are insidious, but not peculiar. There is some tendency to griping diarrhœa, with a discharge,—muco-purulent, slimy, or tinged with blood; unattended, however, with much pain, unless the ulceration has extended downwards within the sphincter ani. The disease simulates dysenteric diarrhœa. Examination per rectum will show the nature of the case.

Any assignable cause is often obscure. The ulceration may proceed from the irritation of impacted fæces, or abrasion from an enema-syringe; but more often it has a syphilitic or scrofulous origin, and there are other concurrent symptoms of either disease.

Treatment must of course have reference to the particular cause of ulceration, whether that be local or constitutional. In the event of contraction sufficient to obstruct the passage of fæces, colotomy may be expedient; and should the ulceration have extended within the grasp of the sphincter, that muscle must be divided to relieve pain and promote cicatrization.

HÆMORRHOIDS—EXTERNAL—INTERNAL, WITH PROLAPSUS OF THE RECTUM.—Hæmorrhoids, commonly called Piles, are essentially an enlargement of the hæmorrhoidal veins, around the anus, or within the sphincter at the termination of the rectum. The pathology of hæmorrhoids will be understood by reference to the anatomical distribution of these veins. Situated between the muscular coat of the rectum and the thin mucous membrane—in the subcellular texture, the hæmorrhoidal veins are naturally large and tortuous, have no valves, and form a looped plexus around the terminal portion of the bowel, just above the sphincter, with branches to the verge of the anus. Hence, these veins are principally submucous, partly subcutaneous. The greater number of them issue in the superior hæmorrhoidal vein, and thence, through the inferior mesenteric vein, enter the portal system; some of the veins, however, issue in the middle hæmorrhoidal vein, and thence, through the internal iliac vein, enter the general venous system. Hence, the circulation in the hæmorrhoidal veins is principally portal, partly systemic.

Hæmorrhoidal affections are named distinctively according to their *situation*. Thus are recognized surgically, Hæmorrhoids, subcutaneous and *external* to the sphincter,—around the margin of the anus; or submucous and *internal*, within the sphincter,—at the termination of the rectum. In the latter situation, this enlargement of the veins, forming internal hæmorrhoids, is accompanied with a tendency to descent and protrusion of the overlying mucous membrane, through the sphincter or anal aperture, constituting a form of Prolapsus of the Rectum. Practically considered, it will, therefore, be convenient to describe Internal Hæmorrhoids and this Prolapsus as one disease. The anal cutaneous integument has a similar tendency to relaxation. But the distinctive terms, external and internal Hæmorrhoids, are not always obvious; the one condition merges into the other, owing to the continuity of the hæmorrhoidal veins. Hence an intermediate variety has sometimes been recognized,—named *intero-external* Hæmorrhoids, situated partly within and partly without the Anus.

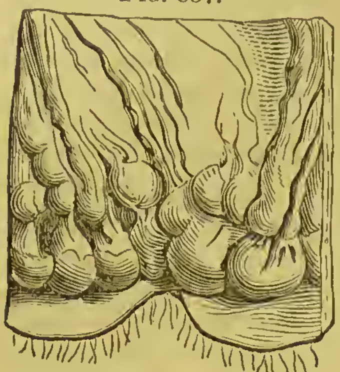
Pathologically considered, Hæmorrhoids—whether external, internal, or intermediate—are a dilated and varicose condition of the hæmorrhoidal veins; accompanied with more or less relaxation of the overlying mucous or cutaneous integument, of the rectum or verge of the anus, respectively. This state of these veins would, so far, be analogous to that of varicose veins in other parts; as of the spermatic veins in varicocele, or of the saphena vein in varicose veins of the leg. But there is this important peculiarity in Hæmorrhoids: their relation, partly to the general venous system, principally to the portal venous system. And this twofold venous relationship nearly corresponds to the situation of Piles, as external or internal to the sphincter ani; and hence the significance of the usual designation of these affections of the hæmorrhoidal veins, as thus distinguished.

External Hæmorrhoids, at first consisting of one or more dilatations of the external hæmorrhoidal veins at the verge of the anus, undergo certain structural changes. The vein becomes thickened and the blood coagulated, forming a thickened sacculus which encloses a dark-coloured clot. Or, the dilated vein, containing fluid blood, may burst, and the blood being extravasated into the adjoining cellular texture, it becomes really encysted, no communication existing between the cyst and the vein. Another form of external pile has been described, as consisting of a congeries of small veins of uniform size, without any appearance of cells, and connected by a dense cellular texture. Plastic infiltration of the cellular texture takes place around either form of pile, investing the sacculus or cyst; and hypertrophy of the skin results. Ultimately, an old external pile atrophies or wastes, in respect to its venous constituent, leaving only the integument in the shape of a loose pendulous prolongation of skin,—a cutaneous excrescence, which is sometimes regarded as another form of external pile.

The *symptoms* of external Piles relate to these various stages of progressive development and decline of this hæmorrhoidal affection. It appears at or near the verge of the anus, in the form of one or more small, rounded, or oblong tumours, which are soft and compressible, and of a livid blue tinge. When largely produced around the anus, a bunch of these venous swellings somewhat resembles Hamburg grapes, to which they have been compared in appearance. They are accompanied with a painfully depressing sense of bearing-down fulness at the fundament, especially in the standing posture and after any straining effort of defæcation or micturition; heat, itching, or smarting add to the patient's discomfort. A crack occurring, sometimes, at the base of an external pile, the irritation and pain thus occasioned aggravate the hæmorrhoidal suffering. When coagulation takes place in the sacculated venous dilatation, or in a cyst resulting from rupture of the vein and extravasation of the blood into the surrounding cellular texture, the tumour becomes solid, harder, and proportionately incompressible; its colour also is less clearly blue, as the vein, cellular texture, and skin become thickened. The fold of skin, which contained the dilated vein, remains, as the vein subsides; and the tumour then presented is a loose, pendulous bit of anal integument. This result is simulated from time to time during the active state of an external pile; the tumour being loose and flaccid when empty in the interval of an attack, and again tense whenever congestion supervenes. In this state—that of congestion—external piles are occasionally liable to *inflammation*, accompanied with increased enlargement of the hæmorrhoid, forming an oval tumour, tense, red, and acutely tender. Suppuration may ensue, converting the pile into an abscess; this bursting, the clot of blood escapes with the pus, and when the abscess closes, the venous dilatation usually becomes obliterated; thus reducing the pile to a small flap of integument. A fistulous opening sometimes remains, which might be mistaken for the orifice of a blind external fistula. Examination with a probe, as to its depth, will at once show the difference.

Internal Hæmorrhoids undergo a parallel series of structural changes. The lower or smaller veins of the plexus, and ultimately the larger veins higher up, are dilated irregularly or into pouches, filled with dark coagula, often compact and hard. A bunch of varicose veins, crowded in the lower ends of the longitudinal folds of the rectal mucous membrane, forms prominent projections of this membrane; thus deepening the pouches there existing, between the folds. A number of smaller dilated veins also sometimes form in the short columnar processes which are situated in the spaces between the folds. Two or three of the larger prominences of the longitudinal folds, meeting below, coalesce; forming a transverse fold just within the sphincter. (Fig. 837.) The arteries, which are abundantly supplied to the lower part of the rectum, and have a longitudinal course towards the orifice where they freely communicate, also enlarge considerably. As the venous or arterial element preponderates, so may be recognized two principal varieties of internal hæmorrhoids—the *venous* and *arterial;* and of the latter, a sub-variety — the *capillary;* these varieties sometimes appearing singly, or associated in the same individual. In old-standing hæmorrhoids, the mucous membrane and submucous cellular tissue become greatly hypertrophied, and extremely vascular. Elongated processes of a polypoid form are thus produced, extending to an inch in length, and projecting transverse folds, an inch or more in width.

FIG. 837.*



The *symptoms* contrast in two important particulars with those of external piles. At first, internal piles present no external appearance at the anus, but they not unfrequently bleed. Hence, the distinction commonly made of Piles into *open* and *blind*, as they bleed or not. The first symptom of internal piles is, generally, an attack of hæmorrhage, venous or arterial, and more or less profuse; merely tinging a motion, or escaping as a few drops of blood afterwards, or to the amount of several ounces. Accumulating within the bowel sometimes, the actual loss of blood from the system may be greater than appears at first sight. This discharge of blood is attended with, or preceded by, a bearing-down weight in the fundament, and more or less frequent desire to micturate. Straining efforts are made to evacuate the contents of the bowel, the passage of fæces being both difficult and painful; at length, hæmorrhoidal tumours, with mucous membrane, are protruded, or prolapsed to some extent at the anus, in the act of defæcation, accompanied with mucous discharge. They then exhibit remarkable diversities of appearance; according to their number, size, variety, and condition. Commonly, there are three distinct prominent growths differing in size; one at each side of the anus, and a third in front,—this, the perineal, being usually the largest. In old-standing cases, there may be four or five such projections. Their boundaries are generally well marked; or the piles merge into each other, forming a nearly circular protrusion. A single pile, of large size, is sometimes the only protrusion, situated towards the front of the anus adjoining the perineum. Consisting of bright-red mucous membrane connected with a loose fold of integument, it often forms in young persons, especially women. The venous and arterial varieties of internal hæmorrhoids may be distinguished chiefly by their colour, respectively; bluish, or reddish, and the latter pulsating, perhaps freely, to the touch, especially at the base of the swelling. Either variety of hæmorrhoid is disposed to bleed readily under pressure with the finger; and the blood is either of a dark, or florid red, colour; in the one case issuing as an oozing hæmorrhage, in the other escaping with a jetting flow.

Extruded Piles exhibit a variable appearance also, depending on their condition as being *congested*, or *constricted* by the sphincter. In an inactive state, and in a relaxed state of the sphincter, they form softish tumours of a red granular appearance, protruding just at the orifice of the anus; when fully protruded, tightly constricted, and congested, they are large, tense swellings of a deep-red or purple colour, and having a smooth surface, which readily bleeds. *Ulceration* takes place occasionally, attacking the tumour in many points at once, but advancing seldom to any great extent. Bushe saw an instance of phagedænic ulceration; and in two cases, hæmorrhage of a florid character supervened. *Mortification* and *sloughing* of the hæmorrhoids may result from complete strangulation by the sphincter; a process of natural cure which sometimes occurs, and, although attended with much suffering, it is free from any danger of hæmorrhage. Dr. Bushe mentions having seen a fatal result in one case out of four which he had met with.

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* Roy. Coll. Surg. Mus., 1280. A ring of internal hæmorrhoids; pedunculated upwards, dilated downwards, with prolapsed state of the overlying mucous membrane, around the anus. A second ring of hæmorrhoids is marked off by a constriction at the lower margin of the sphincter ani muscle. (Hunterian.)

When the hæmorrhoids are of large size, and fully protruded, the integument at the margin of the anus becomes everted, and forms a broad band girting the base of the tumours externally. The skin, thus everted, swollen, irregular, and of a livid colour, is liable to be mistaken for external piles; but its excision in an operation would probably be followed by serious contraction of the anus. External and internal piles often do coexist; but then the sphincter, covered by integument, usually forms a narrow band separating the two. When, as sometimes follows, the two forms merge into each other, their difference may be recognized by the character of the integument—skin or mucous membrane—at the line of junction; though I have seen this difference disappear in oft-protruded piles, as the mucous membrane by frequent exposure acquired the character of skin. Another method of distinction is to gently return the protruded part, requesting the patient, at the same time, to draw up and thus retract the bowel; whatever portion then remains outside is external pile, the reduced portion being internal pile.

Inflammation of internal piles is apt to be induced by the irritation of a costive motion, a brisk cathartic, a slight excess of wine, or irregularity of diet; producing what is called an "attack of piles." Their inflammatory swelling is attended with a sensation of heat, weight, and fulness, just within the rectum; difficulty and pain in passing a motion, and distressing irritability of the bladder. Pain of a dull aching character may be felt in the loins and down the thighs, leading to the supposition in females that the womb is affected. Febrile constitutional disturbance is often severe. Then protrusion takes place at the anus, in the act of seeking relief by stool, or in straining to empty the bladder; the extruded hæmorrhoids become constricted by the sphincter, and the congestion which results from strangulation of the acutely sensitive inflamed piles, entails yet further suffering.

Hæmorrhage is liable to occur, before or after protrusion, and may bring speedy but temporary relief, the piles subsiding; and this natural blood-letting has been regarded as a salutary vent or safeguard in persons having an apoplectic tendency, or disposed to other visceral congestions. But the quantity of blood lost through internal hæmorrhoids varies considerably, from two or three tablespoonfuls to several ounces or pints; and thus the patient's general health may be seriously reduced by oft-recurring attacks, aided by the almost incessant muco-

purulent discharge, and the suffering incident to this hæmorrhoidal affection.

The hæmorrhoidal flux, or discharge of blood from internal piles, depends on a determination of blood to the rectum; whereby also the piles progressively increase in size or grow, as often as it recurs. This afflux of blood and discharge may be periodical, occurring monthly, or at intervals of two, three, or six months; and it may be remittent or intermittent. It continues usually from three to six days, increasing in quantity up to the third or fourth day, and then lessening. Women usually suffer more from piles at the catamenial period; and the flux is coincident chiefly with the time of the menstrual flow, or it may be compensatory for a deficient discharge from the uterus.

Complications.—Piles are frequently associated with other diseases of, or affecting, the rectum; such as prolapsus, fistula, or fissure; they are also connected with diseases of the urinary organs, as enlargement of the prostate, stone in the bladder, and stricture of the urethra; and with diseases of the uterus. In relation to both the latter classes of diseases, as pertaining to the bladder and uterus, hæmorrhoids are the result of the vascular communication of these organs with the rectum, principally through the hæmorrhoidal veins. This connection is most direct between the prostate and rectum; and the straining efforts to relieve the bladder in diseases of this gland, or with stone or stricture, will necessarily dilate and engorge the hæmorrhoidal veins. In thus enumerating the more important complications of hæmorrhoidal affections, I exclude the causative conditions of disease, as of the liver or other organs, in their relation to portal congestion.

Diagnosis.—Internal Piles must be distinguished from prolapsus of the rectum, occurring alone, from polypi of the bowel, and from condylomata about the anus. *Prolapsus* in the form of a rugous flap of mucous membrane, on either side of the anus, is most liable to be mistaken for protruded piles. But the semilunar form of these flaps, the extent of their base, the gliding feeling of the folded membrane between the thumb and finger, and the absence of erection and hæmorrhage, are all diagnostic signs. In *polypus*, its pedunculated character, large size, incapability of erection or collapse, pale-red colour, and slight disposition to bleed, will be sufficiently distinctive of every species of this growth. Moreover, mucous polypus has a very soft spongy feel; and fibrous polypus, a solid and firm consistence. *Condylomata* are readily distinguished from piles, by their flat-shaped, soft, and mucous character, or their warty appearance; and their occurrence in other parts, as the scrotum or vulva.

Causes.—All the causes of hæmorrhoidal affections operate by producing congestion of the hæmorrhoidal veins, chiefly by obstructing or retarding the portal circulation, and thence the return of blood from the rectum; or by inducing a determination of blood to that part. The *structure* of the hæmorrhoidal veins, as being unprovided with valves to break the weight of the column of blood, the large size and tortuous course of these vessels, and the formation of a close plexus of intercommunicating veins, constitute an hydraulic arrangement which predisposes to a slow circulation of the blood around the lower part of the rectum. So also the thin and yielding character of the mucous membrane overlying the veins, and of the anal cutaneous integument below, forms a structural condition favourable to the production of piles, internal and external. The ordinarily dependent position of the rectum has a co-operative tendency. *Predisposing* causes—otherwise—comprise various circumstances, more or less affecting the general or the portal circulation; age—adult life, or middle age; sex—males rather than females are liable in adult life; but conversely, after cessation of the catamenial discharge, in later life; climate—warm and moist, or changeable; period of the year—spring and autumn; hereditary predisposition; plethora, and the suppression of other hæmorrhages; passions, whether violent or depressing; tight lacing, or the application of bandages to the lower limbs; sedentary occupations or habits; sitting on stuffed or on pierced seats; and, as specially affecting the portal circulation;—habitual constipation, disease of the liver or heart, displacements of the uterus, pregnancy, or the development of other tumours in the abdomen or pelvis, and the straining efforts at micturition, with disease of the prostate, stone in the bladder, or stricture of the urethra; and the habitual excess of venery. *Exciting* causes are principally of an irritant character, as affecting the intestinal canal, and which induce a determination of blood to the rectum; such are stimulating purgatives or enemata, excess of wine, spiced or other stimulating food, a costive motion, ascarides, diarrhœa; or external irritation, as hard riding on horseback.

Terminations.—The various terminations of hæmorrhoidal affections have already been alluded to in describing the external and internal forms of piles. Their issues may be thus enumerated: subsidence, or obliteration,—by coagulation, suppuration, ulceration, sloughing.

Treatment.—Remedial, as well as preventive, measures must have reference to the various causes of hæmorrhoids; and the removal of such causes will be suggested in many cases by their nature, whether predisposing or exciting in their action.

Constitutional treatment is both medicinal and hygienic. To relieve portal congestion, the bowels must be carefully regulated by mild aperients which shall influence the whole intestinal canal and promote the secretion of bile, and by attention to diet, with daily walking exercise,—excepting during an attack of piles, when the patient will be sure to seek the recumbent posture. The state of the general circulation should, at the same time, be regarded; in plethoric persons, a depletory course of aperients and reduced diet being indicated; in weak, anæmic persons, a tonic and unirritating dietetic plan of treatment. Thus may be advantageously combined aperients and tonics. A daily dinner pill is a convenient mode of administration; consisting of the watery extract of aloes, compound rhubarb pill, and blue pill, with nux vomica. The watery extract dissolves more readily, and acts before reaching the rectum. Other forms to be recommended are, in particular, a lenitive electuary, consisting of bitartrate of potash and precipitated sulphur, in equal parts, with perhaps a little confection of senna, and sufficient honey or treacle to form an electuary. A teaspoonful may be taken every night at bed-time. This I have been in the habit of ordering, for many years since, in hæmorrhoidal affections, and have almost invariably found it of great service. Taraxacum in large doses—ten or fifteen grains—and Plummer's pill, are both efficacious agents for relieving the portal circulation through the secretion of bile; and the mineral acids, especially the nitro-muriatic, seem to have some influence in that way; while as tonics they support the general circulation. The confection of black pepper, Ward's paste, has long been in great repute as a remedy for piles; a drachm dose being taken three times a day. It is supposed to act directly on the piles as a stimulant application, and might therefore be more advantageously introduced at once into the rectum. This was done by a patient of Sir Everard Home, as related by Sir B. Brodie, and it had the effect of curing him. Cubebs is also taken internally with the same view. I concur with Mr. Curling in not much recommending these remedies; and my experience is that such stimulants are more beneficial in promoting the healing of a sluggish wound after the operation for fistula or fissure in ano. Smoking is said to have an unfavourable influence on piles, a hint to those who indulge too freely in the "weed."

Local applications are important adjuncts to the constitutional treatment, and as a means of allaying pain. *External* piles may be sponged with cold water, or with some sedative and astringent wash, as weak lead lotion, or a weak solution of alum, sulphate of zinc, sulphate of iron, or of the muriated tincture. The unguentum gallæ is also beneficial. *Internal* piles are amenable to similar applications used internally as injections or lavements. Cold water alone, thrown into the rectum every morning, often proves very efficacious in constringing the dilated vessels and softening the motion which follows its use. Medicated astringent injections, as of iron or alum with decoction of oak bark, had better be employed only at bed-time, that during the night any such application may have time to act on the piles. But they should be weak solutions, as a grain of sulphate of iron to an ounce of water; and used in small quantity, only two or three ounces at a time. Citrine ointment is said to be very beneficial when the hæmorrhoids are in an unhealthy state, accompanied with a slimy discharge; a little of the ointment being inserted within the sphincter every night, by means of the finger, which the patient can himself accomplish. An ointment of nitrate of silver is also very useful, although liable to stain the linen.

When piles become *inflamed*, the patient must keep the recumbent position, and cold or warm applications will be appropriate. Pounded ice is highly recommended by Mr. Curling, who finds that it generally gives complete relief in a few hours. Warm fomentations or poulticing may be preferable, and if several piles be affected, a few leeches should be applied around the tumours. An external pile may be opened with a lancet, and the coagulum squeezed out; an abscess should be punctured and poulticed. Internal piles having *protruded*, they must be returned by gentle uniform pressure, to empty them of blood, and then to push them back within the sphincter. If tightly strangulated, they may be punctured in several places with a needle, and cold or iced water applied, with an elevated position of the pelvis; and then by a little manipulation they will probably slip up. Prolonged strangulation and a tendency to sloughing forbid any attempt at reduction; warm fomentations should be used.

Operative Procedures.—When piles are beyond the control of medical treatment, general and topical, or hæmorrhage from them is detrimental to health, operative interference becomes necessary. No such interference should be resorted to if the piles be in a state of active inflammation, excepting perhaps when they are quite external.

Piles may be removed by excision, ligature, or cauterization. The first method is applicable exclusively to external hæmorrhoids; the latter two are appropriate for the removal of internal hæmorrhoids.

Excision is a simple operation, easily performed, and very effectual. The patient lying on his side, with the knees well drawn up and the buttocks held apart, the tumours are seized with a vulsellum or hooked forceps, and successively snipped off with scissors curved on the flat, and applied flatwise at the base of the tumour. Any loose, redundant portion of skin may be included in the excision, but all such integument should not be removed, lest the contraction of cicatrization might leave the patient with a strictured anus. Hæmorrhage is easily controlled by cold and the pressure of a pad, secured by a T bandage. A small, spouting arterial vessel may be twisted. Another method of operation, specially applicable to piles containing a hard blood-clot, is to cut the tumour in two, by transfixing its base with a narrow, curved, sharp-pointed bistoury; then press out the clot between the thumb and finger, and insert a small plug of lint, as the only dressing. After the removal of an *inflamed* external pile, the bleeding relieves the symptoms, and then the part heals rapidly. This would be a most painful operation in the case of inflammation, unless performed under the influence of chloroform; or of local anæsthetic agents, which are equally effectual, as ice and salt, or the ether-spray.

The removal of external piles tends to increase the development of any coexisting internal hæmorrhoids. Prior, therefore, to operation, it will be advisable to administer an injection, in order to determine the necessity for further interference.

Ligature.—Internal piles should be *removed* only by ligature. It is the safest procedure, owing to the liability of hæmorrhage, and the most permanently curative,—in preventing the recurrence of hæmorrhoids with the accompanying prolapsus of the rectal mucous membrane. The operation is, however, not so free from the slightest risk, as Mr. Syme has represented. Erysipelatous inflammation may creep up the bowel; pyæmia and tetanus are also occasional consequences, symptoms of the former affection having occurred in one of my own cases. But no fatal case has come under Mr. Curling's notice, either in public or private practice (1863). Such also has been my own experience. The conditions of internal hæmorrhoids most fitted for this method of removal are—where the tumours consist chiefly of large, prominent, globular or pedunculated, venous dilatations, having a dark-blue appearance; or where the tumours have a bright-red colour and readily bleed, but the prolapsed mucous membrane is thickened or abundant. A marked tendency to uncontrollable hæmorrhage, in any case, will always render the operation requisite. In women, the not uncommon association of some uterine displacement, as the cause of internal piles, should be ascertained; for the operation would prove ineffectual unless that condition were rectified.

The bowels having been relieved by castor oil or other mild aperient, an enema of warm water should be given shortly before the operation, in order that with its evacuation the piles may descend well into view. This effect may be aided by desiring the patient to sit over a pan of warm water, and bear down. Then, lying on the side most convenient to the operator, with his knees drawn up and the buttocks separated by an assistant, one of the tripartite portions of the protrusion is seized with a vulsellum (Fig. 838), double four-pronged forceps, or with the loop-eyed forceps (Fig. 839), and drawn downwards, inclining inwards so as to fairly expose the junction of the anal integument and mucous membrane. At this point, a deep notch or incision is made with a long, straight pair of scissors; applied just on the mucous-membrane side of the junction, as being far less sensitive, and taking care to cut along the inner side of the rectum and not into the pile. The depth of incision must be such as to reach the base of the pile; and if it be pedunculated, long arterial vessels will probably be seen coursing down to the stalk of the pile. The requisite depth is ascertained by the Surgeon moving about the portion of protrusion with the vulsellum, as he clips deeply with the scissors. Handing the former instrument to an assistant, a ligature of fine whipcord is passed down well into the notch, and carried round the root of the pile, and knotted so as to securely strangle it. Sometimes, the base of the protruded portion is too broad to be thus strangulated; then it must be transfixed, by passing a deeply curved nævus-needle, armed with a double ligature, through the base, and each half tied separately. (See Fig. 838.) Other portions of protrusion are ligatured in the same way. It is, however, unnecessary to include every portion of the thickened and prolapsed mucous membrane. An open surface is left of sufficient extent to prevent any re-descent, as contraction ensues; further removal might induce a strictured condition of the rectum. Any external pile or redundant portion of anal integument may be excised, observing the same precaution as to the extent of such removal. The ends of the ligatures are cut off close to the piles, or one end of each should be left long if hæmorrhage be likely to occur. In either case, the protrusion had better be returned into the rectum, otherwise the pain occasioned subsequently by the constriction of the sphincter will be more than that of the operation. If hæmorrhage occur, the ligature-ends, hanging out of the anus, will enable the Surgeon to draw the parts out again and secure any bleeding

Fig. 838.

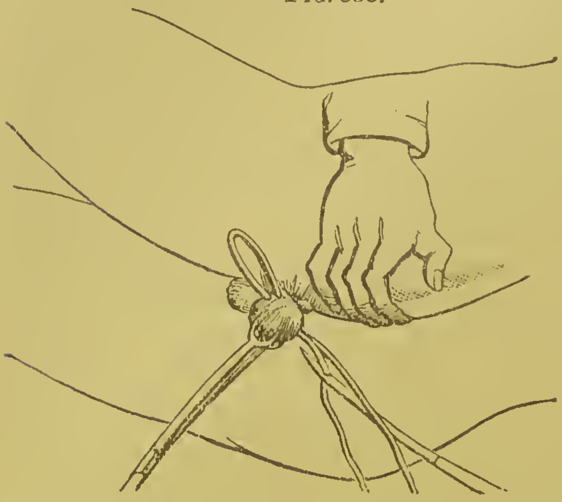
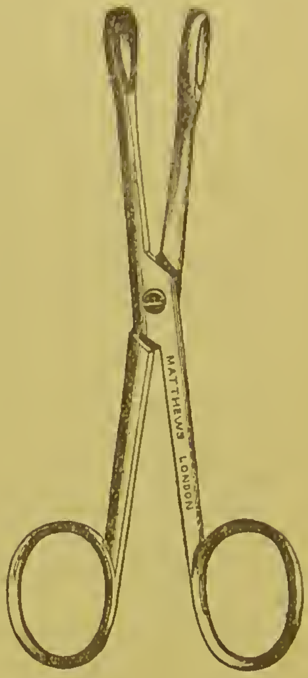


Fig. 839.



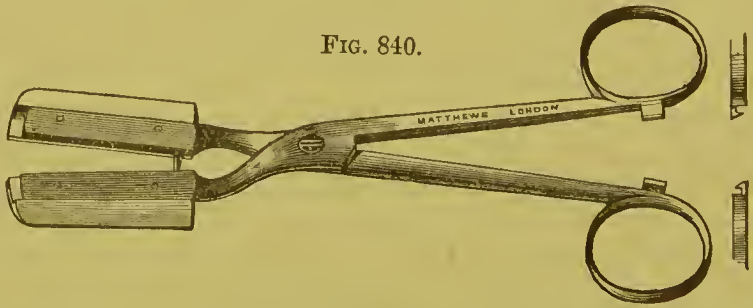
vessel. Chloroform is scarcely requisite in the operation as thus performed,—by cutting through the mucous membrane. The *after*-treatment is very simple; a full dose of opium the first night to prevent pain and any action of the bowels, and the liability to irritation about the neck of the bladder with spasmodic retention of urine. Hyoscyamus and camphor mixture will then also prove efficacious. A dose of castor oil may be given on the third or fourth day; and one or two of the ligatures sometimes come away with the evacuation. The whole are passed in about a week; but still the patient should keep his bed for some days longer, to insure the closure and contraction of the mucous surface, before the upright posture is resumed. Secondary hæmorrhage, usually venous, sometimes happens when the ligatures separate, the blood accumulating in the bowel, and the only indication being that the patient experiences a trickling sensation, and becomes faint. On passing the finger into the rectum, clots are felt, and expelled. Careful plugging with compressed wet sponge, powdered with persulphate of iron or alum, will effectually stop the loss of blood; the sponge having been securely threaded with a twine ligature in order to withdraw it. This compress is carried up the bowel, guided by the forefinger, to above the source of hæmorrhage, say four or five inches, and then pulled down, so as to lock it in position. The plug should not be removed under a week.

Cauterization.—This method of treatment is intended as a substitute for the ligature of internal piles, in certain forms of these hæmorrhoids. When the tumour is flat and sessile, of a bright-red colour, and easily bleeds, its substance consisting more of small arteries than of dilated veins, a ligature is less readily applied to the base of such a shaped tumour, and cauterization with strong nitric acid is equally effectual in destroying the pile. So also if its mucous covering be granular or ulcerated; or without any decided hæmorrhoidal tumour, if the rectal mucous membrane be congested and relaxed, with a tendency to bleed; nitric acid proves very beneficial, especially in the latter condition.

Cauterization, by means of strong nitric acid, was originally recommended by Dr. Houston, of Dublin, followed by Sir W. Fergusson; but in England this method of treatment has been particularly advocated by Mr. H. Smith and Mr. H. Lee. The acid is very easily applied. Protrusion of the pile may be caused as for the operation of ligature; or the application made through an anal speculum—a tube open on one side, by which the diseased surface can be reached. A glass rod or brush dipped in the acid is rubbed freely over the surface, until it assumes an ash-grey colour, when the part should be dabbed with a piece of lint saturated with prepared chalk and water; the protrusion is then returned into the rectum, or the tube withdrawn. The only precaution should be to avoid touching the surrounding anal integument, for which purpose it may be well smeared with oil or grease before applying the acid. Relief soon follows a single application in some cases, and it is unnecessary to confine the patient to bed; so that this might be termed the ready method of treatment as compared with ligature. But its permanently curative efficacy may be doubtful. Cure seems to take place by coagulation of the blood within the pile, obliterating it, then the formation of an ulcerated surface by sloughing, which being succeeded by cicatrization and contraction, may gradually *brace* up the relaxed mucous membrane. But it may result in over-contraction; there is also some risk of erysipelatous inflammation as a consequence of cauterization, although not more probably than after ligature; the probability of secondary hæmorrhage, when the eschars separate, is another consideration, and that the ulcers heal more slowly,—these two disadvantages depending, however, very much upon the more or less extensive application of the acid. As a powerful astringent, Mr. Allingham relies with confidence on the persulphate of iron, used in solution, ℈i. to ℥ss. of glycerine mixed with ℥ss. of water, or as an ointment, ʒss. to ʒi. of unguentum cetacei. This agent is said to be most curative with regard to small, capillary, granular piles; it causes no pain, and always arrests hæmorrhage.

The *clamp*-procedure is a combination of the treatment by ligature and cauterization. The alleged advantages of this method are the avoidance of any danger consequent on ligature, and the shorter duration of treatment,—about two or three days. But, in exceptional instances, spreading inflammation has been thus induced, and pyæmia or perhaps tetanus are occasional consequences; while the period of treatment should not be measured by when the patient can get about again, but by the further time necessary for cicatrization,—the period of cure. The disadvantages also seem to preponderate; there is greater risk of hæmorrhage, primary or secondary, when the slough falls off; and the operation will probably prove less effectual in its permanent results. In regard to the pain of and after operation, the clamp-procedure is certainly more to be dreaded than an ordinary cauterization with nitric acid; and this method quite equals its rival, the ligature, both in the degree and continuance of the suffering from that operation. The tumour is seized and drawn down with a vulsellum, and its base compressed with the clamp (Fig. 840) for a few minutes; its free surface is then excised, not too close, by a pair of scissors, curved on the flat; and the surface thus exposed is touched with the strongest nitric acid, or with the actual cautery, at a dull red heat,—observing not to touch the clamp, lest the heat be communicated and the operation rendered more painful, even although an ivory-plated instrument be used. The clamp is removed, and the part, being well oiled, is returned within the anus, completing the operation. This method, originally introduced by Mr. Cusack, of Dublin, has been chiefly advocated by Lee and H. Smith; the latter Surgeon having devised an "improved clamp," worked by a screw, so that pressure may be gradually taken off, and any bleeding vessel can be readily seen and secured.

FIG. 840.

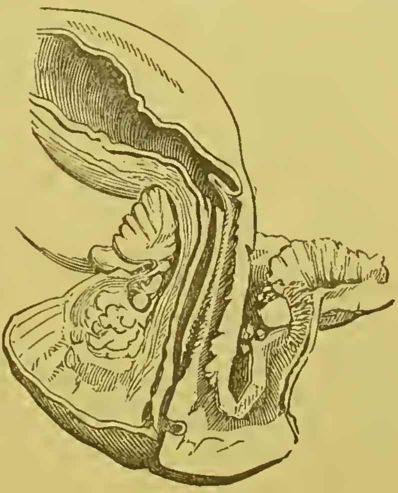


The *galvano-cautery* may be mentioned, as another method of using the actual cautery, but it seems to offer little advantage.

The *écraseur* has been used for the removal of internal piles; a practice in vogue with some French Surgeons, especially Chassaignac; but which has not yet found much favour with Surgeons in this country. Although a painful proceeding, the freedom from hæmorrhage might recommend it; but the probable occurrence of stricture of the rectum after cicatrization, is a very grave objection to this mode of operation.

PROLAPSUS OF THE RECTUM.—*Structural Conditions.*—In connection with internal hæmorrhoids, prolapsus of the rectum is an almost necessary accompaniment. The latter may, however, occur alone, and this protrusion through the anal orifice is sometimes called prolapsus *ani;* an incorrect designation, seeing that the anus, as merely the terminal aperture of the rectum, cannot itself be protruded.

FIG. 841.



Prolapsus recti is met with in two forms. Usually, the *mucous coat* alone descends, owing to its loose connection with the muscular coat; and the prolapsus then consists of an everted duplicature of mucous membrane. Occasionally, the *muscular coat* also descends with this membrane. The possibility of this complete prolapsus of the rectum was formerly doubted by Copeland and other authorities, but the question is now set at rest by the existence of such a specimen in the Museum of King's College. (Fig. 841.)

Signs.—The signs or appearances of prolapsus recti are very obvious; the protruded part has the ordinary vascular-red colour of mucous membrane, and is wet with mucus; the surface may be thrown into transverse rings or folds around the protrusion. Its shape varies, and apparently according to the extent of the part. Commencing usually in the form of one or two lateral folds of mucous membrane on either side of the anus, the protrusion soon becomes an unbroken ring, encircling the anus; as it enlarges, it acquires a cylindrical shape, tapering somewhat towards its free end, and there presents an orifice at the reflection of the membrane upwards, which leads into the bowel. This is now the anal orifice of the rectum. The extent of protrusion varies considerably; in children reaching, perhaps, to six or eight inches; in adults being more limited, and having more of a globular than a cylindrical form. In old persons, the prolapsus frequently attains a large size, owing to the laxity of the sphincter. At either extreme of life,—infancy or old age,—complete prolapsus of the rectum, involving the whole thickness of the gut, is more liable to occur.

The two forms of prolapsus may be readily distinguished; in the descent of mucous membrane alone, the protruded portion is continuous with that investing the sphincter; whereas, with invagination of the whole thickness of the gut, there will be a distinct and deep sulcus between the protrusion and the margin of the sphincter.

In *old-standing* prolapsus, the mucous membrane becomes thickened and leathery, involving the submucous cellular tissue; the sphincter is much relaxed and the anal orifice as much enlarged, while the surrounding integument is thickened, redundant, and pendulous; facilitating the occurrence of prolapsus.

Sympathetic affections of other organs often accompany the depressing sense of bearing down occasioned by the prolapsus. Irritability of the urinary bladder or spasmodic retention of urine are frequently experienced, and much flatulent, dyspeptic irritation, abdominal pain, especially corresponding to the transverse colon, and nausea. Pain sometimes extends across the loins and down the thighs. These symptoms are aggravated when the protrusion is recent and nipped by the sphincter, but the bowel may then recede spontaneously; a more chronic state of loose prolapsus, oft recurring and oft returned, is productive of perpetual suffering.

Congestion, ulceration, and purulent discharge are apt to occur; strangulation and sloughing have also been known to take place, and a natural cure may thus be effected.

Sometimes, a hernial protrusion descends within the prolapsus of the bowel, presenting an unusual fulness, more often in the perineum, with some divergence of the anal orifice. This complication has happened in adults of both sexes, but not, I believe, in children.

The *causes* of prolapsus are predisposing, or exciting, in their operation. *Predisposing* conditions may be fairly expressed by the terms general debility with an atonic state of the intestinal canal. Thus, prolapsus of the rectum is met with most frequently in weakly children or adults, and who are the subjects of atonic, flatulent, dyspeptic symptoms. The *exciting* causes of this affection vary with the period of life; in childhood, ascarides or some other source of intestinal irritation, giving rise to diarrhœa, frequently results in prolapsus,—especially when the child is habitually placed upon a chamber utensil, and there allowed to strain away; in adults, constipation, and especially accumulation of fæces in the rectum, is the more common cause, aided by the straining efforts in defæcation. The bowel comes down with each evacuation, and progressively enlarges. Other causes operate in a similar manner; stone in the bladder, exciting frequent and difficult micturition, is a cause of prolapsus at either extreme period of life; stricture of the urethra, and enlargement of the prostate, as life advances, and the latter especially in old age. The habitual use of copious lavements has undoubtedly a prolapsing tendency. Internal hæmorrhoids result in prolapsus, by dragging down the overlying mucous membrane with them in their descent.

Treatment.—Having regard to the causes of prolapsus, its remedial treatment should be both constitutional and local, the latter including operative measures.

The *bowel* must, of course, be first attended to, when in a state of protrusion. Reduction is accomplished, in the recumbent position, by gentle and uniform compression of the protruded portion with both hands, using a soft towel or piece of lint to protect the mucous surface, and to prevent its slipping from under the fingers. There may be some difficulty in returning the bowel, when the protrusion is large or the sphincter tight. Chloroform might then be administered to overcome the resistance; or, by introducing the finger into the bowel, it may pass up with the finger and not re-descend when it is withdrawn; but, in extreme cases, it may be necessary to partially divide the sphincter by inserting a straight narrow bistoury or tenotomy-knife between the bowel and the anal orifice. When the bowel is fairly returned, a pad of lint or piece of sponge must be applied over the anus, and retained *in situ* by a T bandage. A well-fitting rectal supporter or truss should be worn in old-standing, established prolapsus. But a simple expedient, of American origin, will sometimes prove very efficacious; a strip of thick plaster is drawn vertically over the anus, thus to brace up the relaxed sphincter muscle and the bowel. After an evacuation, a fresh strip is reapplied.

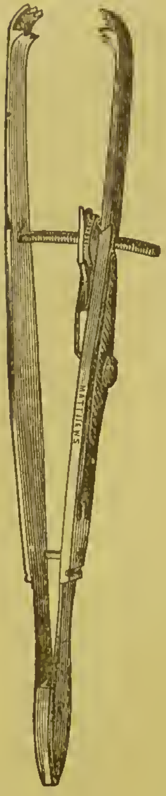
The *constitutional* treatment will vary with the cause of prolapsus. A tonic plan of treatment is always appropriate, but the state of the bowels must be specially regarded. In *children*, and especially the ill-fed children of the poor, it will generally be requisite to correct an irregular action of the bowels or diarrhœa, as depending on improper diet, often an excess of vegetable food. The removal of this cause of intestinal irritation must be coupled with the administration of tonic purgatives, and the rectification of the intestinal secretions. Perhaps the most generally useful form of combination is rhubarb, hydrargyrum cum cretâ, and carbonate of soda or magnesia, taken as a powder every night at bed-time. Ascarides may be the source of irritation in some cases, or the diarrhœa may be sympathetic as depending on dentition. In *adults*, the habitual constipation usually present must be overcome by castor oil, senna electuary, or bitartrate of potash; or by mild enemata, if the constipation be rectal. Stone in the bladder, enlarged prostate, or stricture of the urethra will obviously require attention, when prolapsus depends on these causes.

Local treatment, of a medicinal character, consists chiefly in the use of astringent injections, to correct the relaxed state of the mucous membrane. For this purpose, the decoction of oak bark, with alum, in the proportion of a scruple of the latter to eight ounces of the decoction, will be sufficiently astringent; and a third of the quantity enough for an injection. The muriated tincture of iron, a drachm to a pint of water, is also an excellent astringent; two or three ounces being thrown up, or more according to the age of the patient. Mr. Curling usually prescribes the one formula; Sir B. Brodie preferred the other. Infusion of rhatany, or a solution of tannic acid, may also be employed with advantage. Any injection should be used cold, and allowed to remain in the rectum for some time, which is more conveniently done at bed-time. A *diseased* state of the prolapsed mucous membrane must be managed on ordinary principles. Thus, an ulcerated surface may be brushed with a solution of nitrate of silver.

Operative procedures are resorted to for the cure of inveterate prolapsus. They are excision, ligature, and cauterization. The object is to produce such an amount of contraction, by the healing of a wounded surface, or after slight sloughing of the mucous membrane, as shall effectually and permanently brace up the previously prolapsed part.

Excision, as first proposed by the late Mr. Hey, of Leeds, consisted in removing only the loose and pendulous flaps of skin around the anus; but Dupuytren's modification consists in removing also portions of the mucous membrane. This procedure is certainly requisite, when the prolapsus is large, and the membrane thickened. The patient lying on his back and the legs trussed up as for lithotomy, a fold of skin and mucous membrane, at the side of the anus, and more or less broad according to the laxity of the part, is seized with a vulsellum, or with Willcox's forceps (Fig. 842), drawn a little forward, and excised with a curved pair of scissors. This is repeated on the other side, thus forming two oval wounds, longitudinally; and sometimes further portions may require removal. Any bleeding arterial vessels should be twisted or tied; lest hæmorrhage occurring after the operation, bleeding may take place into the bowel and escape observation.

FIG. 842.



Ligature was originally proposed by Mr. Copeland. It is especially adapted for a condition of voluminous and lax mucous membrane—associated perhaps with internal hæmorrhoids—but unaccompanied with any or much participation of the anal integument. The operation is easily performed, by seizing with a vulsellum selected portions of the mucous membrane, and casting a whipcord ligature around each; cutting off the ends of thread, and returning the whole within the sphincter.

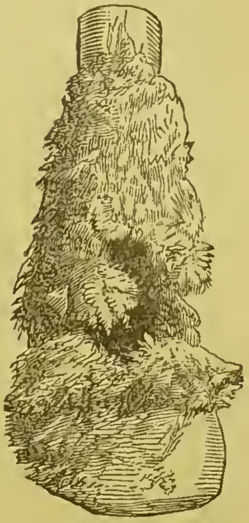
Cauterization is usually effected by means of strong nitric acid, and this method of treatment was much advocated by Sir B. Brodie. It has since been employed in many cases. Mr. Ashton has applied the concentrated acid with the "happiest result," and Mr. H. Smith has found it act like "a charm." There can be no doubt about the truth of these representations, qualified as they are by specification of the appropriate conditions of prolapsus. Nitric acid is suitable in the same condition as that fitted for ligature; but it is specially applicable when the mucous membrane is extremely vascular,—of an arterial character rather than venous, with a velvety appearance; or, again, when the surface has an unhealthy, ulcerated appearance. The acid is applied by means of a glass brush; care being taken to protect the surrounding parts with thick oil or grease, and to dab away any excess of acid from the diseased surface. Stricture of the rectum has been known to ensue; this result having occurred, according to Mr. Allingham's experience, in several cases.

Chloroform may be administered in any of these operations, not so much for its anæsthetic influence, as to relax the incessant action of the sphincter.

POLYPUS OF THE RECTUM.—Any growth springing from the mucous membrane of the rectum, and attached by a narrow and elongated pedicle, is named a *polypus* of the rectum. The tumour, thus characterized by its stalked shape, differs in structure from simple hypertrophy of the mucous membrane, which is also occasionally pedunculated.

Polypus-growth varies in *structure* and *appearance*, forming different species, which have been variously named by authors on this subject. They may be described as—(1) the *vascular* polypus; (2) the *villous*, an extremely vascular growth; (3) the *lobulated*, also vascular, and semi-malignant; (4) the *fibro-cellular* or *mucous* polypus; and (5) the *fibrous* polypus. The first four species are soft in consistence, and the vascular forms are prone to bleed; the fifth is hard, and comparatively bloodless. In point of situation, any form of polypus springs from the mucous membrane within the sphincter; but generally at the lower part of the rectum, ranging from about an inch to three inches from the anus. The size varies in different species; the ordinary vascular polypus being about the size of a pea or a cherry, the villous species attaining to that of an orange. (Fig. 843.) This form of polypus has been specially described by Mr. Quain. Polypus-growth is usually single, but more than one or several may form. The period of life varies, and principally in relation to the species of growth. Vascular polypus is the form commonly found in children; other species chiefly in adults,—a villous polypus, in the rectum of a man aged seventy, was not detected until about five years previously. The specimen is preserved in the Museum of St. George's Hospital. Generally speaking, polypus of the rectum occurs most frequently in children, according to Sir A. Cooper's experience; in adults, according to the observations of Bushe and Syme.

Fig. 843.*



Symptoms.—The general symptoms of rectal polypus are those referable to the presence of a foreign body in the rectum. A sense of weight and fulness, with tenesmus and mucous discharge, is followed by protrusion of the growth when an evacuation occurs, and spasmodic contraction of the sphincter, if the tumour be situated in the anus or is attached by a long stalk higher up. As a growing polypus enlarges, diarrhœa, flatulent distension of the bowels, irritability of the bladder, and other sympathetic affections supervene. Obstruction of the bowel produces variously contorted or figured fæces, and sometimes leads to almost complete retention of the fæces, with intestinal distension. This result happened in the case of the villous growth just alluded to.

In addition to these symptoms of mechanical origin, hæmorrhage, recurring from time to time, is characteristic of the vascular forms of polypus, as distinguished from those which bleed less readily. Malignant vascular polypus is attended, moreover, with certain peculiar symptoms: pain, lancinating and extending up the sacrum and down the thighs, amounting to scalding agony when a motion passes; copious bloody, fetid, purulent discharge, as ulceration supervenes; and the sallow cachectic emaciation of advanced cancerous disease.

Examination of the polypus-growth will determine the particular species; and this can be accomplished, either by injection of warm water, causing the tumour to protrude with the evacuation, or by examination *in situ* with the anal speculum.

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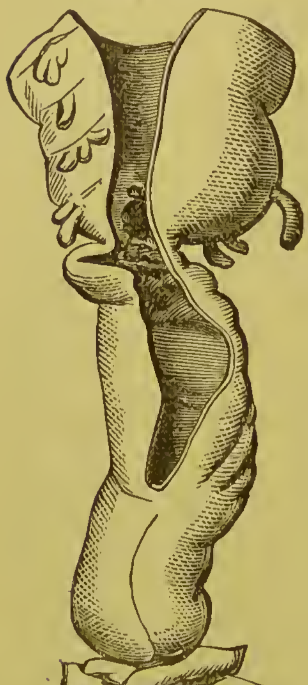
* Roy. Coll. Surg. Mus., 1276. Villous cancer of the rectum—the bowel being inverted. The filaments are from a line to half an inch in length, and the subjacent mucous membrane appeared healthy. There is a large irregular aperture, as if the bowel had been torn, rather than ulcerated. From a person who had an artificial anus in the groin for thirty years before death. This had resulted from mortification of a herniated portion of the sigmoid flexure of the colon; with, at last, complete closure of the intestine below. (W. Lawrence.)

Treatment.—Removal of the growth offers the only prospect of cure. Ligature is preferable to excision, particularly as regards the vascular forms of polypus. Sir A. Cooper and Mr. Syme agree in the advisability of this method of removal. The bowels having been acted on as far as possible, to prevent the necessity of any relief for some days after operation, the tumour is made to protrude as for examination, when it must be seized with a vulsellum and drawn down, until its peduncle is fairly seen; a ligature is then applied around its origin, and the stalk cut off beyond by a pair of scissors, observing not to cut too closely lest the ligature should afterwards slip off. A broad-stalked polypus had better be transfixed at its base, by a needle carrying a double ligature; each portion is then tied. When situated high up the bowel, and out of reach with the fingers, the ligature must be passed by means of a double cannula, or through a gum-elastic catheter, as in ligaturing polypus of the uterus.

STRICTURE OF THE RECTUM.—*Structural Conditions.*—The rectum, like other mucous canals, is subject to contraction or narrowing of its calibre. This state may result from either of two conditions,—simple *fibrous* thickening, or *cancerous* thickening, of the coats of the bowel. These two conditions of stricture differ widely in their nature, symptoms, and treatment.

FIG. 844.*



(1.) *Fibrous Stricture.*—This condition of stricture presents a prominent ring within the cavity of the rectum, entirely or partially surrounding the cavity of the bowel. It consists apparently of a fold of thickened mucous membrane, but principally of fibrous condensation of the submucous cellular tissue; occasionally, there is coexisting hypertrophy of the muscular coat; rarely any change in the peritoneal investment, which generally retains its healthy structure. The structural alteration is sometimes limited in extent, presenting an *annular* stricture (Fig. 844); more often, the induration extends from half an inch to two or more in length, reaching perhaps to three or four inches, or even nearly the entire length of the rectum. If the thickening is greater on one side of the bowel than the other, the passage assumes an irregular winding shape. In rare cases, the contraction of the canal seems due to muscular action, no structural change having been discovered in the coats of the rectum; and also rarely, it is owing to the formation of fibrous bands across the cavity of the bowel, the wall of the gut remaining unaffected. Specimens of both these conditions of stricture exist, the one in the Museum of St. Bartholomew's Hospital, the other in King's College Museum. The *situation* of fibrous stricture is commonly at the lower part of the rectum, from an inch and a half to two inches from the anus, and easily within reach of the finger; next in order of frequency, at two to three inches from the anus; then at four or five inches; and sometimes at the junction of the bowel with the sigmoid fixure of the colon. Very rarely, two distinct strictures have been met with; two such cases were seen by Mr. Curling, one of which originated in dysentery. *Above* the seat of stricture, the rectum is usually dilated, and thickened just above the part diseased. This thickening is owing to hypertrophy of the muscular coat, in consequence of the increased functional action of the bowel at this point to overcome the obstruction. The mucous membrane, above the stricture, is seldom healthy; being either unduly vascular, or ulcerated and pus-discharging. Ulcerated apertures may at length lead downwards along fistulous passages which open externally near the anus, or in the front of the perineum, or behind, as far off as the buttock. Sometimes, a fistulous communication forms between the rectum and the vagina or the urethra, or between the bowel and the cavity of the peritoneum. *Below* the stricture, the coats of the bowel are less changed; but there is frequently diffuse ulceration of the mucous membrane, perhaps hæmorrhoids, or a complete fistula in ano.

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* St. Thomas's Hospital Mus., Q. 151^1. Simple stricture of the rectum; with dilatation of the bowel above, and contraction or narrowing of the passage below.

Symptoms.—Stricture of the rectum commences insidiously. The earliest symptom is that of some mechanical obstruction to the passage of the fæces in the act of defæcation. Hence, frequent constipation ensues, with straining efforts at stool. This difficulty may be readily overcome by a solvent purgative, and the nature of the case remain unsuspected. But the fæces become more scanty, narrowed or figured, and often voided in small lumps. Fæcal and flatulent accumulations above the stricture give rise to abdominal distension; while an irregular, feculent, and mucous diarrhœa occasionally relieves the otherwise habitual tendency to constipation. In the *ulcerative* condition, scalding pain, and bloody, slimy mucous or purulent discharge, are superadded to the symptoms of obstruction. Examination per rectum will affirm or negative the presence of stricture. On introducing the forefinger into the rectum, the stricture can generally be felt; when its nature—whether fibrous or malignant—perhaps the degree of contraction, and its extent, may also be determined. If situated beyond the reach of the finger, the introduction of an oiled wax or gum-elastic bougie may possibly enable the Surgeon to ascertain the presence of a stricture, but not its nature; also its height from the anus, the degree and extent of contraction,—by observing the relative length, the size, and obstructed portion of the bougie. In using the instrument, all these particulars must be gained very cautiously; the curve of the rectum from before backwards, and its inclination to the left high up, being duly remembered; also the promontory of the sacrum, against which the point of the bougie is apt to impinge; and the presence of the natural folds of mucous membrane which may intercept its progress. Unless these circumstances be observed, as to the course and interior of the canal, some degree of obstruction might convey the impression of stricture. Indiscriminate pressure might then rupture the mucous membrane and open the peritoneal cavity; the point of the instrument seeming to pass, really turns downwards into the rectum. When the obstruction is partly due to spasmodic action, it yields more readily under the influence of chloroform.

In the *diagnosis* of stricture of the rectum, sources of compression external to the bowel, from diseases of the adjoining viscera, must not be overlooked, as conditions to which the symptoms may be referable. Such are enlargement or tumour of the prostate, retroversion or backward flexion of the uterus, or an ovarian tumour.

The *causes* of fibrous stricture relate to its pathological origin. It proceeds from chronic inflammation of the mucous membrane and submucous cellular tissue; resulting in fibrous deposit, especially affecting the latter texture. Ulceration or abrasion of the mucous membrane, resulting in contraction, may also produce stricture. The *exciting* causes are necessarily various; any source of irritation, as the impaction or passage of hardened fæces, foreign bodies, as fish-bones, etc.; or the straining efforts in forcible defæcation. Syphilis has undoubtedly been known to produce stricture of the rectum, either as a primary or secondary affection. In women, difficult parturition or the unskilful use of instruments for delivery may induce inflammation. Of twenty-eight cases of stricture of the rectum which came under Mr. Curling's observation, twenty were women; and in nine of them the stricture commenced after labour, some of which were distinctly attributed to an injury at the time. The greater liability of females to this disease accords also with the experience of Mr. Copeland and of Dr. Bushe. An external injury to the part has occasionally been the cause, as a severe kick in the fundament.

Treatment.—The principle of treatment is mechanical *dilatation* of the stricture. Considerable judgment will be requisite in carrying out this treatment. Besides attention to the natural course and character of the canal and the nature of the stricture, two additional rules should always be observed in using dilatation,—namely, never to make any forcible effort, and never to cause pain, nor the risk of hæmorrhage, which might be perilous. The instrument used should always pass with ease. The bowels should be kept free by mild aperients, especially castor oil.

When situated *low down*, dilatation can be effected with tolerable facility, by the introduction of a proper-sized gum-elastic bougie, or compressed sponge-tent. Either form of dilator must be allowed to remain in the stricture; the bougie for ten or fifteen minutes, the tent may remain for twelve or twenty-four hours. Dilatation must be renewed every two or three days, and with instruments of progressively increasing size. Tent-dilatation is, however, the most effectual, owing to the swelling character of the compressed sponge. A very tight annular or almost membranous stricture may be advantageously notched with a protected bistoury,—my "concealed fistula-knife" being serviceable for this purpose. The posterior aspect of the canal is the safest for a slight incision, not to endanger the peritoneum. Dilatation can then be accomplished by widening the seat of contraction with the forefinger of each hand, introduced into the bowel; and maintained by a bougie or tent. Various other dilating instruments have been devised, by Weiss, Bushe, Arnott, Sir C. Bell, Charrière of Paris, Nélaton, Bermond, Todd, Costallat, and Coxeter; all of them are ingenious, yet not so efficient as the bougie.

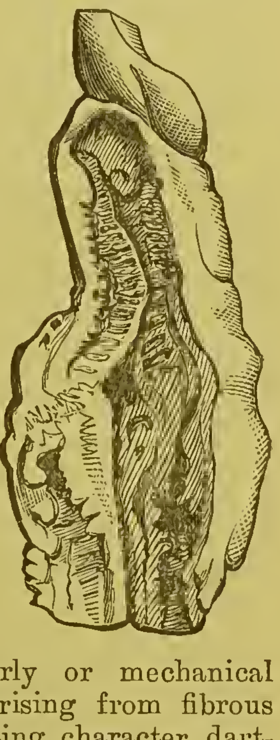
If the stricture be situated *high up*, the same treatment may be adopted, but with very great caution. A wax or a very flexible gum-elastic bougie should be used. Pain or spasm following the use of instruments admit of relief by the occasional introduction of opiate suppositories. Constipation often remains, even after dilatation of the stricture; but as the result of loss of power in the distended bowel above the seat of obstruction, the action of the bowel will perhaps be restored by tonics, and oleaginous enemata; or it may be preferable to administer castor oil in small doses daily, or a lenitive electuary of senna and sulphur, thus to obtain a regular soft evacuation. Cod-liver oil seems to be laxative as well as nutritious; and in any case, the diet should be carefully regulated, to avoid any accumulation of hard, indigestible food. But, however temporarily successful dilatation may prove, a permanent cure is seldom if ever effected. Dupuytren, Bushe, and Dr. Colles, of Dublin, emphatically concur in the same opinion; Mr. Curling takes a more favourable view of this plan of treatment. Undoubtedly much will depend on having to deal with fibrous stricture in an early stage of its formation, and in prolonging the course of dilatation for some weeks or months after apparent cure.

Palliative treatment affords relief to the pain and discharge. Nitrate of silver, in the proportion of five grains to the ounce of distilled water, or the mild citrine ointment, may be applied with advantage to the diseased mucous membrane within the stricture, by means of a camel's-hair brush passed through an anal speculum. Hæmorrhage may be restrained by cold water, solution of alum, or other styptic injection, administered through a long tube. Plugging the rectum will be necessary, in the event of any serious or persistent hæmorrhage, such as would be consequent on forcible dilatation.

In extreme cases, of almost complete obstruction, Amussat's operation of colotomy must be resorted to.

(2.) *Cancerous Stricture.*—The coats of the rectum are liable to the formation of every species of cancer—scirrhous, encephaloid, colloid, and epithelial; resulting severally in stricture of the bowel. Any such growth forming external to the rectum may so press upon and implicate the bowel, as to have the same effect. The disease is usually situated at the lower part of the rectum, within three inches from the anus (Fig. 845); less frequently, at the junction of the sigmoid flexure of the colon; but any portion of the bowel may be affected.

Fig. 845.*



Symptoms.—Commencing insidiously, the early or mechanical symptoms of obstruction are similar to those arising from fibrous stricture. But the excruciating pain, its lancinating character, darting up the sacrum and extending down the limbs, the aggravated intensity of the pain, as of molten lead, when the fæces pass, and especially when ulceration has supervened, with the increased tendency to hæmorrhage, and copious, fetid, purulent discharge;—these symptoms are more or less diagnostic of cancerous stricture. Subsequently, the peculiar cachectic appearance and emaciation are distinctive consti-

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[*] Roy. Coll. Surg. Mus., 1266A. Scirrhous cancer of the rectum,—section of the bowel, showing great thickening of its coats, and stricture of the canal. (Professor Partridge.)

tutional symptoms. Examination per rectum will probably determine the diagnosis. If the disease be situated as usual—low down—on introducing the finger into the bowel, considerable thickening of the bowel and narrowing of the passage are felt; but the consistence of this diseased portion of the bowel differs widely; the resistance being that of cartilaginous induration—in scirrhous stricture; and resembling a soft cushion—in encephaloid or other soft cancerous stricture. If the finger can be insinuated into the stricture, an irregular nodulated surface is felt, and which is more extensive than usual in fibrous stricture. Sometimes nodules, hard or soft, are found, round about the seat of stricture. On withdrawing the finger, it is covered with blood and pus. Fistulous communications form between the bowel and adjoining parts,—the vagina, bladder, or urethra, which also become implicated. The lymphatic glands in the neighbourhood of the rectum become enlarged, and secondary cancer may be developed in other internal parts, —the lumbar glands, peritoneum, or liver. Death results from fæcal obstruction, or from these complications.

The liability to cancer of the rectum varies with the *period of life*, and *sex*. It occurs generally in middle life, and women are said to be more subject than men. This latter predisposition seems doubtful. Of twenty-one cases noted by Mr. Curling, seventeen were males, and only four females. Again, of eleven cases noted by Mr. Baker in the "Med.-Chir. Trans.," vol. xlv., eight were males, and only three females. Of thirty-five cases at St. Mark's Hospital, as recorded by Mr. Carter, nineteen were men, and sixteen women.

Treatment.—*Palliative* measures are alone practicable. They consist chiefly in a light nourishing diet and a tonic course of treatment; with regulation of the bowels and solution of the fæces by castor oil and other mild aperients, and opiates administered internally, and per anum by injection or suppository, to assuage pain. Chloroform applied locally to the anus by means of a piece of lint covered with oil-silk, or inhaled as usual, has given marked ease, although not pushed to the extent of insensibility; and its anæsthetic influence may be resorted to daily, if necessary.

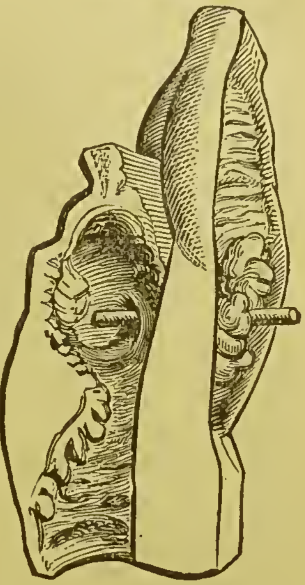
The introduction of any instruments is always hazardous. Bougies and tents must not be thought of. Feculent accumulations above the stricture may sometimes be reduced by passing a long tube through the stricture, and then giving an injection of warm water. But this proceeding must be conducted with the utmost caution.

Excision of the cancerous mass was proposed and practised by Lisfranc; and afterwards by Dieffenbach, with success in no less, it is said, than thirty patients, not one of whom died in consequence of the operation. Nevertheless, that such a procedure is justifiable may well be doubted. Colotomy, in the left loin, seems a far more surgical resource, both as a means of relieving misery connected with the rectum and of prolonging life. This operation was originally advocated by Mr. Curling, on the physiological principle that by discharging the fæces, without allowing any passage through the rectal stricture, the part affected will thus be set at rest. He administers an injection to somewhat distend the colon, in order to secure it more readily when reached by the lumbar incision. The results of operation have been encouraging,—both for the relief of the excruciating pain during evacuation and the other rectal symptoms, and in the duration of life.

RECTAL FISTULÆ.—Fistulous communications are liable to form between the rectum and adjoinining organs: the bladder, as Recto-vesical Fistula, in the male; and the vagina, as Recto-vaginal Fistula, in the female.

(1.) *Recto-vesical Fistula* is not often met with. It may result from disease, forming an ulcerative communication between the rectum and bladder, as in cancer of the gut (Fig. 846); or be of traumatic origin, as from a wound of the bowel in the operation of lithotomy.

FIG. 846.*



Signs.—The escape and discharge of the contents of either organ—of urine *per anum*, and of feculent matter and flatus *per urethram*—at once proclaims the nature of the lesion; while digital or ocular examination through a double-bladed anal speculum, will plainly detect the situation and size of the fistulous opening. When resulting from disease, the cancerous or simple nature of the fistula can thus also be readily discovered. Constant irritation, excoriation, and offensive odour accompany the discharge of urine and feculent matter; the patient leading a life of seclusion and misery.

Treatment.—The object is to close the fistulous opening; but the surgical procedure appropriate for this purpose must depend on the cause and extent of the opening. *Cancerous* fistula is incurable; and all that can be done is to palliate the patient's suffering, by opiate and detergent injections, with constitutional support. *Traumatic* fistula, if recent, and of small size, may perhaps be induced to contract and close, by introducing a pencil of nitrate of silver occasionally, or by means of the actual cautery,—a red-hot wire, or platinum wire heated by the galvanic current, as devised by Mr. Marshall; an anal speculum being used to protect the bowel, and effect the cauterization exactly within the fistulous opening. An old, callous fistula, and of larger size, cannot be closed in this manner; it will be necessary to lay it open, and convert the rectal or anal into a perineal fistula, so that it may granulate and heal from the bottom. This is accomplished by passing a grooved staff through the urethra, and cutting down upon it; dividing the sphincter and intervening portion of bowel. A strip of lint is then placed in the wound.

(2.) *Recto-vaginal Fistula* is usually of traumatic origin; the result of sloughing of the posterior wall of the vagina, from long-continued impaction of the head or the use of instruments during parturition. The size of the opening varies considerably, from that of a small perforation to a large portion of the posterior vaginal wall. It may be complicated by laceration of the perineum.

Signs.—The discharge of feculent matter and flatus from the vagina at once shows the existence of a recto-vaginal communication; and examination with the finger, or inspection by introducing the duck-billed speculum, will reveal the situation and extent of the aperture.

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* Roy. Coll. Surg. Mus., 1269. Recto-vesical fistula, from cancerous ulceration. The ulcer of the rectum is deep and irregular, and extends from the level of the prostate gland for nearly three inches upwards; a soft, flat tumour, about two inches long, projects around the vesical aperture, just above the ureters. There was another such tumour, of smaller size, higher up on the wall of the bladder. All the tissues around the rectum were indurated and contracted. (Hunterian.)

Treatment.—The procedure for closing a recto-vaginal fistula must be determined primarily, according to whether the opening be simple, or complicated with laceration of the perineum.

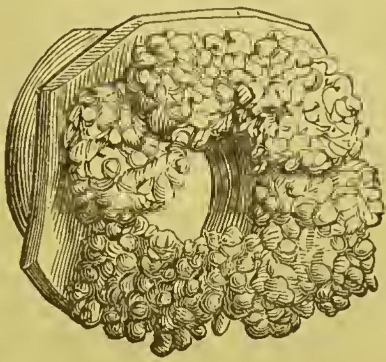
Simple Recto-vaginal Fistula, if recent, and of small size, may perhaps be closed by cauterization gently with nitrate of silver, a red-hot wire, or the platinum loop, applied within the opening; the anterior wall of the vagina being well raised by the duck-billed speculum. An old fistula, and of larger extent, must be closed by a plastic operation. The bowels having been thoroughly emptied by aperients, and an enema on the morning of operation, the duck-billed speculum is introduced and the fistula, in the posterior vaginal wall, entirely exposed; the patient lying recumbent, with the legs raised and held apart, and the buttocks at the edge of the table, as for lithotomy. The Surgeon sitting opposite the perineum, he freely pares the margin of the opening; then, the edges are brought into even and easy apposition, transversely to the axis of the vagina; to effect which it will be necessary to divide the sphincter ani on either side, in order to overcome tension, and spasmodic muscular contraction after the operation. The sides of the opening are evenly secured in apposition by means of silver or platinum wire sutures; taking care to transfix the whole thickness of the gut, excluding its mucous membrane, and observing to bring the sutures through the vaginal mucous membrane half an inch beyond the pared edges, above and below. The suture-wires are fixed by a close twist of the wire across the line of aperture, or they may be passed through a perforated leaden shield, overlying the aperture, then through split shot, which are clamped with forceps close upon the shield, so as to fix it upon the vaginal wall. The ends of wire are snipped, and the operation completed. *After*-treatment is most important. It consists in preventing any action of the bowels for a week or ten days, by keeping the patient under the influence of opium, until firm union is established. A laxative aperient, or an enema of castor oil and gruel, may then be administered. Cleanliness is also essential to success; the vagina being syringed with cold water two or three times a day, and the urine drawn off by a catheter as occasion requires. About the end of a week, the sutures may be snipped through, and gently withdrawn. A small aperture, even a pin-hole opening, not unfrequently remains, and obstinately resists closure. This must be treated, as already described, by touching with nitrate of silver or the wire-cautery. In one such case—after the usual operative procedure—I applied the actual cautery on seven different occasions, before I succeeded in closing the pin-hole aperture.

The *complication* of a *Lacerated Perineum* must be treated by the appropriate operation, described in connection with that condition; the fistulous aperture being closed by paring, and sutures. I have thus closed a recto-vaginal fistula, and subsequently a laceration of the perineum, which existed in the same woman; and in whom also a tight annular membranous stricture of the rectum was cured, by dividing its free margin with scissors, at two or three points of its circumference, and which I then dilated as usual, by the occasional passage of a bougie.

(3.) *Entero-vaginal Fistula* is a rare occurrence; a communication having been formed between the small intestine and the vagina. This condition would simulate a recto-vaginal fistula; but it may perhaps be distinguished by the feculent discharge having a more yellow colour, and less stercoraceous character.

Such fistula is *incurable.* An operation has been performed by Roux and Casamayor, with the view of establishing a communication between the small and large intestine; but the deep and difficult dissection necessary for this purpose has proved fatal.

Fig. 847.*



Anal Tumours.—Various forms of tumour and excrescence are liable to beset the Anus. They are principally—epithelial cancer, fibrous tumour, warts, and condylomata. (Fig. 847.) The nature of these growths is the same as when occurring in other parts of the body, and they are recognized and diagnosed by similar symptoms as in other regions.

The *treatment* is excision, which may generally be effected most conveniently by a stout pair of scissors curved on the flat. Chloroform, ice and salt, or the ether-spray, will be requisite; the operation being acutely painful, and spasmodic action of the sphincter interfering with its performance. Wet lint-dressing is often sufficient; but a persistent oozing hæmorrhage must be arrested by application of the perchloride of iron or other styptic, and sometimes by the actual cautery, with a compress and T bandage. Great cleanliness should be observed, to prevent any irritation which might induce reproduction of the morbid growth.

Anal Contraction, or stricture of the anal orifice, results from tight cicatrization, in consequence of the healing of ulcers or wounds of the anal integument. This may take place after operations of excision; as the removal of external piles, or of anal tumours.

The only *treatment* is dilatation, gradually effected by bougies or compressed sponge-tents. It is remarkable how small an opening will suffice for the purpose of adequate defæcation.

Injuries of the Rectum.

Wounds.—The Rectum is liable to *wounds* or *laceration* by external injury, as a severe kick in the fundament, or the introduction of a foreign body; but more commonly from internal causes, as during straining efforts of defæcation, and the passage of large and hardened fæces, or in parturition. Wounds of the rectum are sometimes caused by surgical misadventure, as in lithotomy, or unskilful catheterism; or surgically, in the operation of puncturing the bladder through the trigone vesicale for the relief of retention of urine. Injury by wound or laceration may involve the whole thickness of the wall of the rectum or the mucous membrane only; and it is evident that the lesion may vary in direction, as being vertical or transverse.

The *symptoms* will be sudden pain and hæmorrhage, occurring in connection with some occasion of injury; and examination per rectum may discover the seat and nature of the lesion. Defæcation is painful and the fæces are streaked with blood; or with pus, when suppuration takes place. Granulation and cicatrization follow, or the wound becomes an ulcer of the rectum.

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* Roy. Coll. Surg. Mus., 1264. A cluster of lobed and nodulated warts around the anus.

Treatment consists in keeping the bowels easy and free by mild aperients or emollient enemata, and the avoidance of stimulating food; with rest in the recumbent position. Cleanliness after each evacuation will do much locally to promote healing; but an intractable sore or ulcer should be brushed over with a solution of nitrate of silver occasionally. It may become necessary to make an incision through the mucous membrane, along the ulcer, as directed in the treatment of fissured anus.

Foreign Bodies.—All sorts of foreign bodies may be found in the rectum; having been swallowed, or introduced directly into the bowel through the anus, and sometimes maliciously. By either mode of entrance, the list of such substances on record is most numerous and diverse in their nature; and their variety is increased by those formed in the body and impacted in the rectum. Hence may be found concretions,—biliary, intestinal, and fæcal; of substances swallowed,—the bones of fish and small bones, stones of fruit, coins, pins, needles, knives, nails, sealing-wax, cedar pencils, brown paper, etc.; and as introduced through the anus,—pieces of stick, ivory, cork, horn, metal, rings, ferrules, bottles, pots, cups, a shuttle with its roll of yarn, a knitting-sheath, a pig's tail, a broom-handle, the leg of a chair, etc.

The *symptoms* of any such foreign body impacted, will be pain, hæmorrhage, and obstruction; on examination, it will be found within the rectum, and sometimes sticking out of the anus. Any sharp spiculated body occasions the acutest agony, especially on the slightest motion, so that the sufferer becomes afraid to move. In one such case, the patient crawled into my consulting-room, looking the picture of misery, and could only point backwards to the fundament. I immediately introduced my finger into the rectum, when, about two inches from the anus, I touched a bar lying across the bowel and stretching it out at a point on either side. I dislodged this bar with a twist and withdrew it through the anus. It proved to be the rib-bone of a rabbit. The patient remembered having eaten rabbit a few days previously, and the night before I removed this faithful rib, he was suddenly seized with excruciating pain in the lower part of the bowel, aggravated as he rolled about with suffering during the night. The relief was instantaneous, leaving only a dull aching sensation which wore off in a day or two.

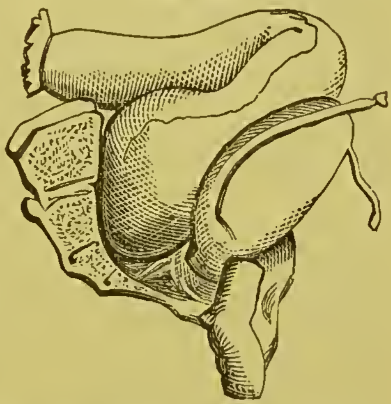
Treatment in any case must, of course, be extraction of the foreign body, as soon as possible. But this may be difficult to accomplish, according to the situation of the body, its size, and nature.

Concretions offer some advantage over other substances. Emollient enemata of soap-and-water or olive oil may do something towards softening feculent masses; thus facilitating their extraction or discharge, piecemeal. They can then be scooped out with a lithotomy-scoop or a table-spoon. Other foreign bodies present special difficulties, and each almost its own peculiar difficulty. Removal is effected by the finger or the hand, coupled with dilatation of the anus, which admits of gradual enlargement so as to pass the whole hand; or instruments may be necessary. The *modus operandi* must then be left to the ingenuity of the Surgeon. Sir W. Fergusson extracted a bougie from the rectum of an old gentleman, by means of lithotomy forceps. In another case, which Mr. Liston relates, a pig's tail had been mischievously thrust by some students into the rectum of an old woman; the bristles were in the wrong direction for extraction of the tail, and by sticking into the mucous membrane, it resisted any attempt. At length, a tube was slid up between the bowel and the tail, when the latter was easily withdrawn. In other cases, it has been found necessary to divide or break the substance in order to remove it. And in yet other cases, removal has not been accomplished by any manipulation or instrument. Whether the foreign body be extracted or not, in not a few cases death has resulted from violent intestinal inflammation.

CONGENITAL MALFORMATIONS OF THE ANUS AND RECTUM.

Imperforate Rectum, as a congenital malformation or deficiency, may exist in two primary conditions: imperforate anus; or, the anus leading into a cul-de-sac, imperforate rectum. The former condition—imperforate anus—presents five varieties: (1) simply membranous obstruction of the anus; (2) with partial or complete deficiency of the rectum; (3) communication with the neck of the bladder or the urethra, in the male; (4) communication with the vagina, in the female; (5) external communication, or fistula. The latter condition—imperforate rectum—presents two varieties: (1) membranous obstruction; (2) partial or complete deficiency of the rectum.

FIG. 848.*



Signs.—When, after birth, there is no *evacuation*, during the first thirty-six or forty-eight hours, of the usual dark-coloured meconium fluid, and perhaps sickness coexisting, the medical attendant or the nurse is led to discover that the *anus* is *imperforate;* if indeed this deficiency had been overlooked at the time of birth. The condition of the rectum, when obstructed, is almost sure to be undiscovered at birth; but if *no bulging* in the fundament be perceived after some hours have elapsed—the anus being imperforate—the lower end of the *rectum* will probably be deficient also. (Fig. 848). *Imperforate rectum* is distinguished by the presence of an anal cul-de-sac. The finger can sometimes be introduced into this sac to the extent of its depth,—half an inch to an inch and a half. Those varieties of imperforate anus in which a *communication* exists with the bladder, the vagina, or externally, admit of less direct recognition during life. But the discharge of feculent fluid through the urethra, the vagina, or an external fistulous opening, will be severally diagnostic of these malformations. In the latter state, the situation of the opening varies in the two sexes. In the male, the fistulous opening may be in the perineum just behind the scrotum, in the scrotal raphé, or anterior to the scrotum. In the female, it occurs in the perineum close to the vagina, or at the posterior commissure of the vulva. In both sexes, and in all these situations—vesical, vaginal, and perineal—the vent is insufficient and defæcation more or less difficult. Hence, constipation and intestinal dilatation ensues, especially as the fæces acquire consistency, and sooner or latter life becomes endangered.

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* London Hosp. Mus., A. *e.* 78. Imperforate anus, and hypertrophied coccyx; in a child, three days after birth. Mr. McCarthy found that the coccyx reached nearly to the symphysis pubis; he removed a portion, but as there was no appearance of the rectum, colotomy was performed in the left inguinal region,—the sigmoid flexure of the colon being opened. The child lived until the sixteenth day after the operation. P.-M. examination showed that the rectum terminates in a cul-de-sac above the recto-vesical fascia, and therefore out of reach for any safe operation.

All the foregoing malformations seem to occur more commonly in male children than in female. Thus, of 100 cases collected by Mr. Curling, 68 were males and 32 females. But of 100 cases recorded by M. Bouisson, 53 were females, and 47 males. So, therefore, the liability of sex is doubtful.

Treatment.—Operative interference is necessary or becomes necessary to preserve life, in consequence of the anal or rectal obstruction; or to remove a wretched and disgusting infirmity, in the cases of fistulous communication, vesical or vaginal, or of an external perineal opening. The principle of operation is to remove the obstruction by the formation of an anal opening in the situation of the natural anus, —the establishment of an artificial anus in the natural situation; or by the enlargement of a fistulous communication at some distance off; substitute procedures being, an artificial anus in the left iliac region or the left lumbar region, respectively, by Littré's or Amussat's operations.

Imperforate Anus, as a simply *membranous* obstruction, may be easily remedied. The integument over the seat of the termination of the rectum is usually so thin that the meconium can be distinguished by the dark-blue or black colour of the skin; and bulging becomes plainly visible when the child cries. A central crucial incision should be made with a sharp-pointed bistoury, and the four angles of the integument excised. The aperture must then be maintained by the introduction of an oiled tent or the passage of a bougie daily, until the anus is fully established, which seldom requires more than a week.

Deficiency of the rectum, coexisting with imperforate anus, should be managed on the same principle. An incision is made at the site of the anus, exactly in the middle line; and then the dissection must be prolonged cautiously towards the coccyx, extending to the depth of an inch and a quarter. The closed termination of the bowel may thus be reached, or in the course of a few hours it comes into view, being forced down by the infant's crying. When reached, the bowel must be opened freely with the bistoury, then drawn down to the external wound, and there attached by sutures. After this procedure, the same precaution will be requisite as before, in order to see that the anus shall become permanently established; a bougie should be passed occasionally for several weeks. In the event of a failure to reach the bowel, colotomy must be performed, in the left iliac region.

Imperforate rectum—the anus opening into a cul-de-sac—necessitates similar operative interference. By dilating the cul-de-sac with a sponge-tent, for a few hours, the seat of operation is rendered more perceptible. Then, on introducing the finger into the anal cul-de-sac, if the obstruction is membranous, the termination of the distended rectum can be distinctly felt as a thin septum under the point of the finger. This may be opened by an exploratory puncture with a grooved needle or fine trocar, and if meconium fluid or gas escape, a free aperture should be made with a sharp-pointed bistoury. If the distended end of the bowel cannot be felt, the anal cul-de-sac should be enlarged by an incision, carried towards the coccyx, so as to divide the posterior wall of the sac; and search made in this direction to the depth of an inch and a half or two inches from the anus. Failing to reach the bowel, further operation should be abandoned, and colotomy, in the left iliac region, resorted to.

Rectal communications with the bladder, vagina, or perineum—co-existing with imperforate anus—may require operative interference, eventually, to preserve life, as constipation and intestinal dilatation supervene; and in any such case, interference will be justifiable to relieve and render tolerable the otherwise wretched state of existence.

In the case of a communication with the *bladder*, the opening is situated at the neck of the bladder, or more commonly at the anterior part of the prostatic portion of the urethra; it is not usually direct, but through the medium of a narrow channel, and is always small and insufficient. But the urethral aperture appears to be usually of a valvular character, so that, although fæces can pass into the urinary canal, the urine is unable to enter the rectum. The same operation should be performed as in the condition of imperforate anus coupled with deficiency of the rectum. Amussat, in 1835, first proposed that the end of the bowel should be brought down and secured to the integumental wound at the site of the anus; a proceeding much advocated by Dieffenbach. A passage lined with mucous membrane is thus made for the escape of the fæces, and the liability of feculent extravasation averted, and its consequences, diffuse cellulitis and peritonitis. Colotomy must be had recourse to, when the bowel is seated at a depth beyond an inch and a half to two inches.

Rectal communication with the *vagina*, or a fistulous opening in the *perineum*, may be remedied by either of two operative procedures—enlargement of the original outlet, or the formation of a new anus at the natural site, and closure of the abnormal anus.

Recto-*vaginal* communication has been cured in both ways. Enlargement of the original outlet, first suggested by Vicq-d'Azyr, is effected by division of the posterior wall of the vagina and the perineum as far as the coccyx, and retaining a cannula in the bowel. A similar operation was performed by Dr. Barton, of Philadelphia, and another by Dr. Parish, of the same city. In one case, the infant was aged nine months; in the other, fifteen months. To establish a new passage at the natural site, a curved director or sound should be passed through the vaginal opening into the bowel, with its point directed to the site of the anus; this is then cut upon in the middle line, the incision being carried backwards towards the coccyx. A free opening having thus been made in the bowel, it is brought down and secured by sutures to the margin of the integumental wound. Dilatation must subsequently be maintained. Closure of the abnormal communication with the vagina may take place spontaneously; as in a case operated on by Dr. Sharpless, of Philadelphia, where the opening closed two months after the substitution of the operation-anus. Generally, it will be necessary to assist contraction and closure by touching the edges with the actual cautery; or, if the opening be large, the edges must be pared and brought together by sutures. After either procedure, the bowels should be kept at rest by opiates, for several days, until closure has taken place.

Recto-*perineal* communication, as the third variety of imperforate anus, has also been treated successfully by both modes of operation. Enlargement of the original outlet is performed by an incision towards the coccyx, and the application of sutures. The results of this procedure were quite satisfactory in two cases operated on by M. Goyrand; one a male infant, six months old, in whom, at the age of sixteen years, defæcation was free and the power of retention complete, even when the motions were lax; the other a female, aged eleven months. Equally satisfactory results have been obtained by Mr. Gowlland and by Mr. Curling, in a male and a female infant respectively. The formation of a new anus at the natural site has proved successful in the hands of M. Guillon and others. But enlargement of the original outlet will be preferable in all cases where the opening is sufficiently near the site of the natural anus; this is generally the condition in the female, and sometimes in the male. When, however, the opening is situated beneath the penis, or in the scrotal raphé, the other operative procedure must be resorted to.

The general *result* of unrelieved and long-continued rectal obstruction is well shown in a case of imperforate anus with recto-vaginal fistula, operated on by Mr. Lane; the child being four and a half years old. The bowel was opened at the anus, and the septum between the two apertures was divided. Death ensued in twenty-three days. The continual strain upon the rectum had produced distension to a size almost incredible; the rectum and sigmoid flexure of the colon formed an immense reservoir capable of holding five pints of fluid, which occupied the pelvis, the hypogastric, both iliac, and part of the umbilical regions, displacing the viscera upwards and diminishing the cavity of the thorax.

Functional Disorders of the Rectum and Anus.

Under this head may be conveniently noticed certain functional disorders, which are unaccompanied with any apparent structural condition of disease of the part affected, whether the Rectum or Anus. Such are Atony of the Rectum; Irritable Rectum or Sphincter; Neuralgia of the Rectum, or of the Anus; Pruritus Ani.

Atony of the Rectum.—In paraplegia the retentive powers of the rectum and of the sphincter are both lost; but the tonic muscular power of the rectum may itself be deficient, rendering the bowel incapable of thoroughly expelling its contents. Fæcal accumulations are apt to form. This occurs in habitual rectal constipation; a state in which the fæces are transmitted through the colon into the rectum, but there lodge.

Besides the ordinary symptoms of constipation, there is also a sense of fulness and weight in the rectum, and severe bearing-down pains occasionally. A mucous discharge, resulting from constant irritation, may bring away a little feculent matter from the surface of the mass, and simulate diarrhœa.

The cause of this atonic condition is usually the too frequent and copious use of enemata, a practice more common on the Continent than in this country. French ladies are, I believe, especially subject to the complaint, through the prevalent custom with them more particularly of neglecting the calls of Nature, and then seeking relief by lavements. It occurs also among the enfeebled by age.

The *treatment* of fæcal accumulation in the rectum should be chiefly mechanical. Impacted and indurated fæces may be broken up and scooped out, by means of a lithotomy-scoop or a dessert-spoon. Injections, in the first instance, have but little effect in dissolving the mass, and generally return immediately; after extraction of the larger lumps, the remainder can be thus removed, and the bowel washed out.

Irritable Rectum.—In this functional condition of the rectum, there is frequent and urgent desire to defæcate; analogous to the frequent and urgent desire to micturate, as denoting irritability of the urinary bladder. And the analogy between these two affections holds good still further, in the common cause of rectal irritability being an unhealthy and irritating state of the fæces, in consequence of gastro-intestinal derangements; just as vesical irritability depends frequently on morbid conditions of the urine. Both affections also depend often on morbid states of the nervous system, and are much influenced by the attention being directed to the part. Various diseases also of the bowel give rise to its irritability, and in particular, ulcer of the rectum; but the irritability is not then purely functional.

The treatment of rectal irritability must have reference to these diverse causes—whether the state of the alvine evacuations, or of the nervous system, or the associated diseases of the rectum.

Opiate suppositories are most effectual in restraining the distressing inconvenience of an irritable rectum.

Irritability of the *sphincter* alone is sometimes met with, unaccompanied by any apparent disease of the part. It occurs usually in hysterical females. Pain and difficulty in defæcation are experienced, owing to spasmodic contraction of the sphincter, resisting the expulsive power of the bowel; and when the finger is forced in, it is tightly grasped by the muscle as if girt by a cord. In old-standing irritability, the muscle often becomes hypertrophied, encircling the finger like a thick unyielding ring.

The *treatment* of this affection consists in mild laxative aperients to insure soft motions, and sedative applications. An ointment containing chloroform, opium, or belladonna should be used by means of a grooved bougie; so that some of the sedative shall reach the mucous membrane lining the internal sphincter, which is also occasionally affected. The simple introduction of a bougie appears to afford great relief, when resistance to the evacuation of fæces is considerable. In obstinate cases, and especially when the sphincter has become hypertrophied, a slight incision into the muscle will usually give relief. It should be done on one side, towards the ischium. Constitutional treatment, as in other hysterical affections, must be attended to; but often, after having failed in every way to overcome this troublesome complaint, it ceases spontaneously.

Neuralgia of the Rectum.—Unlike irritability, this complaint is essentially a painful affection of the rectum, and always unaccompanied by any discoverable disease of the part. The character of the pain is neuralgic, in its being intensely severe, and not excited or aggravated by the action of the bowels or by pressure. But it is not so distinctly paroxysmal, coming suddenly and after a while disappearing; it is singularly persistent, although varying in intensity at different times; and may continue for years. The pain does not seem referable to any particular spot, extending perhaps up one side of the bowel, as a dull aching pain. Neuralgia of the rectum occurs chiefly in females.

No *treatment* can be designated curative. Sedative applications have some influence in allaying the pain; opiate suppositories in particular, or the belladonna ointment introduced by a bougie. Constitutional treatment should not be neglected; colchicum and bicarbonate of potash may prove beneficial in a gouty diathesis; or quinine and iron in persons debilitated and worn down by suffering.

Pruritus Ani.—Itching at the anus, unconnected with any diseased state of the part, is symptomatic of various causative conditions. Rectal constipation, ascarides, congestion of the mucous membrane, not distinctly hæmorrhoidal, and other disorders of the bowel, are common causes; or over eating and drinking, and especially the indulgence of some particular taste, as for salmon or champagne. The complaint may be sympathetic; as of chronic enlargement of the prostate, or of some uterine or ovarian irritation. Constitutional causes are also not uncommon; as suppressed gout, or an excitable state of the nervous system, induced perhaps by overwork and anxiety, or excessive smoking. Anal itching and irritation are usually more intolerable at night, depriving the patient of sleep; it is frequently provoked during the day by sitting long upright. Scratching or rubbing the part only aggravates the suffering, and results in excoriation, or the production of a peculiar dry, harsh, and leathery state of the skin, easily disposed to crack.

Treatment of this affection consists in removing any exciting cause, and using sedative applications. Hence, it will be imperative to regulate the bowels, and avoid any stimulating condiment, food or drink; or the removal of ascarides may be indicated as the source of irritation; and in any case, absolute cleanliness must be enjoined. As a sympathetic affection, the treatment of anal itching will be that of the organic disease, which is the distant source of irritation. And any constitutional cause, as a gouty condition, must be met by appropriate remedies. But a tonic plan of treatment will be requisite when the complaint seems to be more purely neurotic; iron and quinine, arsenic, or strychnine, may then be given with marked advantage; and the bromide of potassium with hydrate of chloral is extolled by Mr. Allingham, as a hypnotic, to be taken at bed-time. Of topical applications, the liquor opii sedativus, chloroform ointment or vapour, will often afford relief. The latter may be applied by pouring a little chloroform into a wine-glass, which is held to the anus. Mr. Curling highly recommends a lotion composed of a drachm of the sulphuret of potassium and eight ounces of lime-water; the infusion of tobacco, with five grains of borax to the ounce, is also very efficacious. In chronic cases, astringent lotions are often beneficial; as lotions of alum, tannin, or the muriated tincture of iron. Counter-irritation I have found to be singularly remedial, when the anal itching depends on ovarian irritation; a blister applied over the iliac region, on the tender side, has not unfrequently acted as a charm, all other treatment having been quite ineffectual.

THE GENITO-URINARY ORGANS.

CHAPTER LXI.

INJURIES OF THE BLADDER—URINARY DEPOSITS AND CALCULI—STONE IN THE BLADDER—LITHOTOMY AND LITHOTRITY.

The Genito-Urinary Organs comprise the kidneys, ureters, bladder, prostate gland, urethra, penis, scrotum, and testis,—in the male; the uterus and ovaries, the vagina and vulva,—the organs of generation in the female. Of these organs the kidney, in respect to its diseases, falls within the allotted province of Medicine, and incidental notice only will be taken of the ureter in this work. But the Student in Surgery must equally study diseases of the kidney as part of the pathology of the urinary system.

Surgical Anatomy of the Bladder, Prostate Gland, and Urethra.

The Bladder, Prostate Gland, and Urethra are so often the scene of various operative procedures, that a Surgical view of the Anatomy of these Organs—as to their structure, position, and relative connections—will advantageously lead the Student to a clearer and more correct apprehension of the diagnosis and treatment of their injuries and diseases. To the Practitioner also, such an introduction to this subject may prove serviceable for reference to that anatomical knowledge, which he must carry with him in the practice of this department of Surgery.

Urinary Bladder.—*Structure.*—The bladder is a musculo-membranous bag or sac, and is richly endowed with blood-vessels, lymphatics, and nerves—sympathetic and spinal. Situated in the pelvic cavity, but during childhood partly in the abdomen, this organ is placed behind the pubes and triangular ligament, in front of the rectum or of the uterus and vagina, which in the female separate the bladder from the bowel. This hollow organ communicates with the ureters and the urethra, its physiological function being that of a reservoir for the urine, which, as secreted by the kidneys, is received through the ureters and retained, until from time to time convenience may permit of the voluntary discharge of that fluid through the urethral canal.

I proceed to a more detailed description of the organ and its relations, as thus defined.

The bladder may be regarded as essentially a hollow expansion of *mucous membrane* continuous with that of the ureters behind and the urethra in front; the external surface of this sac is overlaid with bands of *muscular fibres*, the unstripped and involuntary variety, disposed in figure-of-eight spiral loops, vertically, obliquely, and horizontally; * springing, for the most part, from the neck of the bladder—

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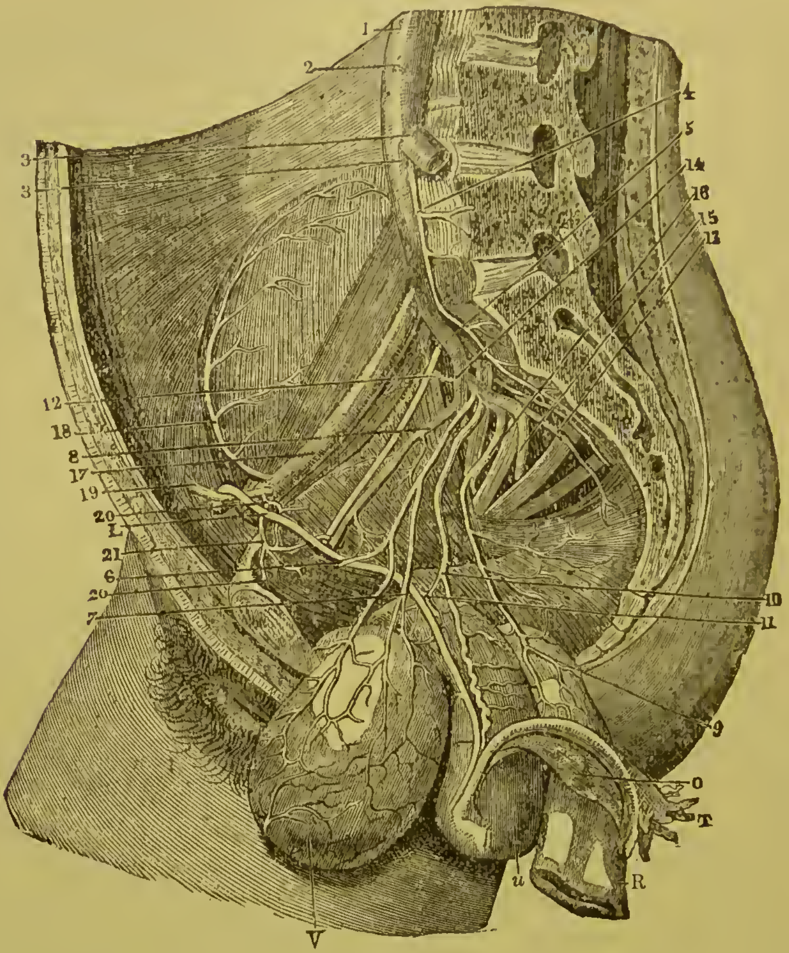
* Original Dissections by J. Bell Pettigrew, Museum Roy. Coll. of Surgeons, Eng., and same authority, "On the Muscular Arrangement of the Bladder and Urethra," etc., "Phil. Trans.," 1867.

to be presently noticed—these muscular bands are then entwined over and around the organ, leaving intervals of mucous membrane uncovered; a layer of *cellular tissue* intervenes between the two, this submucous texture containing an abundance of the finely coiled fibres of elastic tissue. The muscular arrangement forms the "detrusor urinæ" muscle, and a marked band around the neck of the bladder is named "sphincter vesicæ." *Blood-vessels* are plentifully supplied to the bladder, and have the following distribution:—The internal iliac artery, from its anterior division, gives off the *superior* and *inferior vesical* branches (Fig. 849), and in the female the *uterine* arteries also, all of which ramify and terminate in the cellular texture and mucous membrane; the *veins* form large *plexuses*, situated chiefly at the neck,

Fig. 849.*



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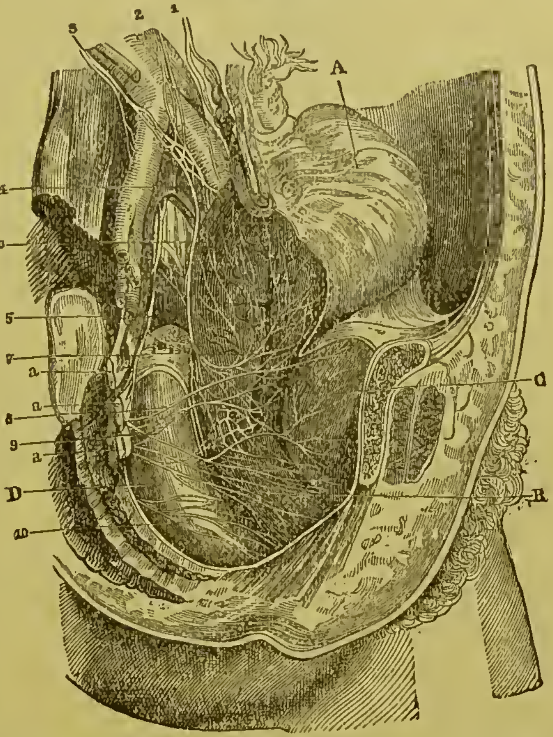
* Side view of Pelvis, in Female; showing (hypogastric) internal iliac artery.—V, bladder; U, uterus; O, ovary; T, trumpet-shaped end of fallopian tube; R, rectum; L, round ligament of uterus. 1. Abdominal aorta. 2. Trunk of inferior mesenteric artery. 3, 3. Common iliac artery. 4. Middle sacral artery. 5. Internal iliac artery. 6. Umbilical artery, or obliterated hypogastric. 7. Vesical arteries coming off from the obliterated hypogastric artery. 8. Obturator artery. 9. Middle hæmorrhoidal artery. 10. Uterine artery. 11. Vaginal artery. 12. Ilio-lumbar artery. 13. Lateral sacral artery. 14. Gluteal artery. 15. Sciatic artery. 16. Internal pudic artery. 17. External iliac artery. 18. Circumflex iliac artery. 19. Epigastric artery. 20. Pubic branch of the epigastric. 21. Anastomotic branch of the pubic and obturator. (From A. Jamain.)

sides, and base of the bladder, and, terminating in the internal iliac veins, are accompanied in their course by *lymphatic vessels*, which enter lymphatic glands around the internal iliac artery, and thence proceed upwards to the lumbar glands. *Nerves* are supplied in equal abundance. They proceed partly from the fourth nerve, or sometimes the third nerve of the *sacral plexus*,—itself derived from the spinal cord, and these *spinal* nerves are distributed to the base and neck of the bladder; but the *hypogastric plexus* from the great *sympathetic* cords (Fig. 850)—a plexus situated between the common iliac arteries—supplies two large prolongations which descend into the pelvis, one on either side, to form two lateral pelvic plexuses, which communicate with a few offsets from the first or two first ganglia in the sacral cord of the sympathetic; and these pelvic plexuses, expanding over the sides of the bladder and rectum, or vagina, are distributed to the upper portion and remaining part of the organ, not supplied from the sacral plexus. Both sets of nerves—spinal and sympathetic—*communicate* in the pelvic plexuses; and the sacral nerves, third and fourth, on either side, contribute branches thereto, aided by a filament or two from the second sacral nerve. Many ganglia are interspersed in each plexus, thus constituted, particularly at the junctions of the spinal and sympathetic nerves. The filaments from either plexus pass along and accompany the branches of the internal iliac artery, given off to the bladder, as already mentioned. The muscular bands, blood-vessels, lymphatics, nerves, and cellular texture, together form a second coat, overlying the "mucous coat;" while, externally, this "muscular coat" is partially invested with the peritoneum, forming the "peritoneal or serous coat," which, however, extends over only the posterior half of the bladder, being reflected so as to leave the anterior half of the organ uncovered, or free of this investment.

FIG. 850.[*]



Ligamentous Connections.—The *peritoneum* covering the front of the rectum—or uterus, in the female—is reflected backwards over the posterior part of the under surface or base of the bladder, forming the *recto-vesical* pouch or *cul-de-sac*, in that situation; thence curving upwards and forwards over the posterior surface and adjoining part of each side of the bladder to gain the summit, it is again reflected to either side of the pelvis; and lastly, from opposite the back of the pubes to the wall of the abdomen. These peritoneal reflections are named *false ligaments* of the bladder, and are *five* in number. The portions of peritoneum extending from the back of the pelvis to the bladder, and which bound the recto-vesical pouch, form two *posterior* false ligaments; the lateral reflections, extending from the sides of the bladder, to the pelvis, form two *lateral* false ligaments; and the superior reflection gives rise to the *superior* or *suspensory* false ligament. But all these so-called ligaments represent one continued reflection of the peritoneum, as conducted apparently by the course of the internal iliac arteries, and their continuation, the obliterated hypogastric arteries in the adult. Guided by these vessels, and, it may be said, by the ureters, the peritoneum passes forwards along the sides of the middle portion of the rectum to the under surface of the bladder, thence up its sides to the summit, and so to the abdominal wall. In the latter situation, the obliterated *urachus*, a fibro-cellular cord, passes from the top of the bladder, in the interval between the two hypogastrics; and with them reflecting the peritoneum upwards, these three cords ascend along the linea alba to the umbilicus. The *true* ligaments of the bladder are prostatic portions of the recto-vesical fascia, on either side of the pelvis; *four* such portions of this fascia, or ligaments, being recognized: two anterior, in front of the prostate, and two lateral, at the sides of that body. Their derivation from the recto-vesical fascia, and their attachments as ligaments of the bladder, may be traced from the *pelvic fascia*. This fascia descends from the brim of the pelvis, and covering the upper part of the obturator internus muscle, as far as a white line extending between the body of the pubes and the spine of the ischium—the fascial origin of the levator ani muscle—the fascia there splits into two layers. One layer, being continued downwards over the lower part of the obturator muscle, is thence named the *obturator fascia;* the other layer, inclining inwards and downwards from the white line, passes as a broad expansion, over the upper surface of the levator ani muscle, to the side of the rectum, bladder, and prostate, thus acquiring the name of the *recto-vesical* fascia. This visceral layer of the pelvic fascia assumes ligamentous connections in the middle line. Attached to the back of the body of the pubes, just internal to the pubic origin of the levator ani muscle, the fascia, on either side of the pelvis, passes backwards, in front of the prostate, to the neck and adjoining part of the bladder, in the shape of two roundish, strong white bands, a right and a left, forming two *anterior* true ligaments; while another portion of the fascia, broader and thinner, passing back on the side of the prostate, to the neck and side of the bladder, forms two *lateral* true ligaments. The anterior true ligaments, therefore, are better defined; and between the two is a cellular interval, in which lies the dorsal vein of the penis, or clitoris in the female. These bands of the fascia cover in the anterior fibres of the levator ani—the levatores prostatæ—which are spread over the prostate, here closing the outlet of the pelvis; a continuation from the lateral bands completely ensheaths the prostate, as a *capsule*, an offset of which passing backwards encases the vesiculæ seminales; and the rectal portion of the fascia, from either side, passes inwards between the bladder and bowel, ensheathing the rectum and supporting the bladder; but in its prolongations backwards on these viscera the fascia gradually becomes mere cellular membrane, and is lost in the thin pelvic fascia over the front of the sacrum and pyriform muscle, where the vessels and nerves perforate it to reach the bladder.

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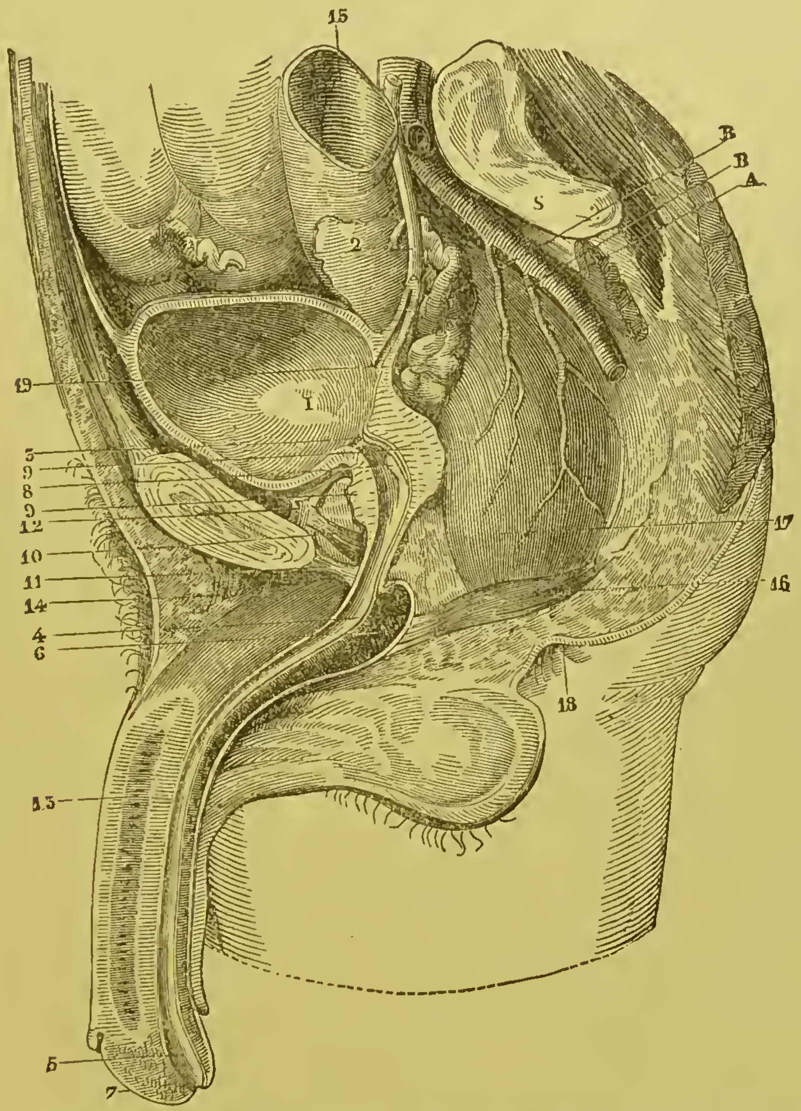
[*] Side view of Pelvis, in Female; showing hypogastric plexus of nerves.—A, uterus enlarged by gestation; B, vagina; C, bladder; D, rectum; *a*, sacral plexus. 1. Nerve from renal plexus to ovary and uterus. 2. Splanchnic nerve—left. 3. Splanchnic nerve—right. 4. Plexus formed by these nerves. 5. Sacral ganglion. 6. Great sympathetic nerve. 7. Uterine nerves. 8. Vesico-uterine branch from sacral plexus. 9. Anastomosis of sacral plexus with hypogastric plexus. 10. Fourth sacral nerve, giving branches to hypogastric plexus and to pelvic viscera. (From A. Jamain.)

Fig. 851.*



The *outlet* of the *pelvis* is closed in by the recto-vesical fasciæ of opposite sides, which, like the levatores ani muscles, form a partition, concave above, convex below; this, however, is perforated by the rectum and prostate, both of which derive sheaths from the membrane in their passage through it. In the *female*, the recto-vesical fascia has the same arrangement, except that besides the rectum, the vagina, instead of the prostate, perforates and is ensheathed by it. By means of the ensheathing prolongations of this membrane, and the corresponding attachments of the subjacent levatores ani muscles, the pelvic viscera are slung in the cavity of the pelvis, with an easy mobility upwards and downwards. As the musculo-membranous floor rises or descends, these viscera are drawn upwards, or tend to protrude towards the outlet of the pelvis in the perineum.

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* Side view of Pelvis, in Male.—1. Bladder. 2. Ureter. 3. Neck of bladder. 4, 5. Urethra. 4. Cul-de-sac of bulb. 5. Fossa navicularis. 6. Bulb. 7. Glans penis. 8. Verumontanum, or caput Gallinaginis. 9, 9. Prostate. 10. Wilson's muscle. 12. Pubo-vesical ligament. (The last two are not recognized now.) 11. Triangular ligament of urethra. 13. Corpus cavernosum. 14. Suspensory ligament of penis. 15. Rectum. 16. Sphincter ani. 17. External longitudinal muscular fibres of rectum. 18. Anus. 19. Seminal vesicle. A, internal iliac artery; B, B, middle hæmorrhoidal arteries; S, sacrum. (After Blandin.)

The *relations* of the bladder to surrounding parts are surgically very important.

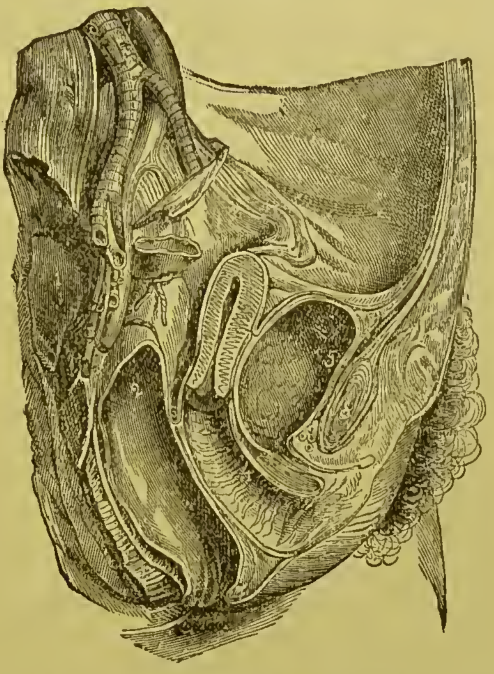
The *anterior* surface of the bladder, entirely free of peritoneum, is situated behind the body and symphysis of the pubes, and the triangular ligament in the pubic arch. (Fig. 851.) This latter relation of the bladder corresponds to the anterior half of the perineum, in front of the anus; or, in the female, to that smaller part of the vulva which extends between the clitoris and the orifice of the urethra. Above the pubes, the bladder, when distended, rises to the lower part of the abdominal wall. At the lowest part of the anterior surface of the bladder, a narrow funnel-shaped portion, named the *cervix* or *neck*, is surrounded by the prostate gland, a body about the size and shape of a horse-chestnut, which transmits the first or prostatic portion of the urethral canal; and the prostate, thus standing in front of this part of the bladder, intervenes between this organ and the lower part of the triangular ligament.

The *base*, or *inferior fundus*, the largest and most dependent portion of the bladder, is directed downwards, and inclined backwards according to the degree of distension; it rests upon the rectum, its second portion, the vesiculæ seminales and vasa deferentia intervening, and further back, the recto-vesical pouch of the peritoneum. This *cul-de-sac*, broad behind in the interval between the iliac arteries on either side of the rectum, narrows forwards, and is tucked, as it were, under the bladder. In front is a triangular space, where the base of the bladder lies free of peritoneum, and attached to the rectum by the recto-vesical fasciæ; the apex of this space touches the prostate, its base behind is limited by the peritoneal pouch, and the sides are bounded by the vasa deferentia, and the seminal vesicles outside these tubes, as both converge forwards to enter the prostate gland. In this space the bladder is punctured *per rectum*, to relieve retention of urine. Usually, the *recto-vesical pouch* of peritoneum extends forwards to a point corresponding to about *one inch* and *a half* from the tip of the coccyx, or about *four inches* distant from the anus; sometimes, however, the pouch reaches forwards to the prostate, leaving no triangular space uncovered at the base of the bladder. In the *female*, the base of the bladder rests upon the anterior wall of the vagina, and further back on the lower part of the uterus, these organs being placed between the bladder and rectum. The *utero-vesical* pouch of peritoneum extends forwards only as far as between the *uterus* and bladder, leaving the vagina uncovered and adherent to the bladder at the fore part of its base.

The *posterior* surface of the bladder is in contact with the rectum, or, in the *female*, with the uterus; but this surface of the bladder is covered entirely by the peritoneum, reflected upwards from the rectal or uterine *cul-de-sac.* (Fig. 852.)

The *sides* of the bladder are each crossed obliquely from behind by the cord of the obliterated hypogastric artery, passing forwards and upwards to the summit of the organ. Behind and above this cord, the peritoneal investment of the posterior surface is prolonged forwards over the sides of the bladder; but in front of the cord, which reflects the peritoneum, the sides are uncovered, being, however, here supported by an expansion of the recto-vesical fascia. This otherwise uncovered portion of the bladder, on either side, is in immediate relation to the *ureter*, which transmits the urine from the kidneys into the bladder, and the *vas deferens* or excretory duct of the testis. The ureter, a tube like a white band, having descended into the pelvis across the common or the external iliac artery, it curves downwards, forwards, and inwards in the posterior vesical ligament, arching *below* the obliterated hypogastric artery, to gain the lateral aspect of the base of the bladder, which it enters about two inches and a half from the prostate gland, and rather less than that distance from the ureter on the opposite side; the tubes penetrate the coats of the bladder obliquely for nearly an inch, passing through the muscular coat and then between it and the mucous coat, to open upon the inner surface of the bladder by two oblique slit-like apertures. The vas deferens, a small round cord-tube, one on each side, having entered the abdomen through the internal abdominal ring, this cord curves backwards and downwards on the side of the bladder, to near its posterior surface; then, crossing the hypogastric artery and the ureter on the *inner* side of that tube, the cord turns forwards along the base of the bladder, lying to the inner side of the seminal vesicle, where, becoming enlarged and sacculated, the vas deferens enters the base of the prostate gland, there joining with the duct of the seminal vesicle to form the common ejaculatory duct. The *vesiculæ seminales*, one on each side, are narrow, club-shaped, sacculated bodies, the large end being directed backwards, and extending to about two and a half inches in length. Consisting of a convoluted tube, encased in an offset of the prostatic portion of the recto-vesical fascia, each vesicle lies on the outer side of the vas deferens, and converges from behind forwards to the prostate.

FIG. 852.*



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* Side view of Pelvis, in Female; showing viscera laid open.—1. Sacrum. 2. Rectum. 3. Recto-vaginal pouch of peritoneum. 4. Vagina. 5. Bladder. 6. Common iliac artery. 7. Common iliac vein. 8. Fibro-cartilage of symphysis pubis. (From A. Jamain.)

In the *female*, the ureters pass along the sides of the cervix uteri and upper part of the vagina to reach the bladder; and the vasa deferentia, vesiculæ seminales, and prostate gland are absent.

The *summit* or *superior fundus* of the bladder, covered behind by peritoneum, is free in front, where that membrane is reflected upwards to the abdominal wall by the three cords already mentioned, namely, the two obliterated hypogastric arteries, and the urachus in an interval between them; this anterior and uncovered portion of the summit looks towards the abdominal wall above the pubes. Here the bladder can be punctured without wounding the peritoneum. Convolutions of the small intestine rest upon the top of the bladder, and sink down behind its posterior surface into the peritoneal pouch,—recto-vesical, or utero-vesical, *cul-de-sac.*

Internal Surface of the Bladder.—The inner surface of the *mucous coat* of the bladder presents certain characters worthy of notice, and some peculiarities which mark the interior.

The mucous membrane is soft and smooth, and of a pale rose colour; it is studded with minute follicles, most numerous near the neck of the bladder, and the whole surface is covered with a spheroidal epithelium. The vesical mucus has, it is said, an alkaline reaction, and contains alkaline and earthy phosphates. The membrane—having these characters—is loosely attached to the muscular coat by means of the subcellular layer; so that when the bladder is empty, the surface generally is thrown into small internal folds or wrinkles, and when distended, there is some tendency to protrusion in the intervals of the muscular bands—thus, perhaps, giving rise to *sacculation* of the bladder.

The *inferior fundus* is the most capacious and dependent part of the bladder; in front, it presents a small triangular space,—the *trigone vesical;* situated immediately behind the orifice of the urethra, the apex of this space is directed forwards to that orifice, and the base is a transverse line slightly curved forwards, between the orifices of the two ureters, which form the posterior angles of the space; while the sides are marked by two linear ridges passing obliquely backwards and outwards from the urethra to the ureters, and which correspond to two small fasciculi of muscular fibres,—the muscles of the ureters lying under the mucous membrane. These muscles arise from behind the middle lobe of the prostate, and pass to the oblique slit-like openings of the ureters; they may, therefore, so act upon these openings, as to maintain their obliquity and thus prevent any reflux of urine into the tubes; or, by drawing their apertures downwards, may facilitate the flow of urine into the bladder. The trigone—having the boundaries already noticed—corresponds to the triangular space at the *base* of the bladder, which lies between the prostate in front, and the peritoneal pouch behind, bounded laterally by the vasa deferentia and vesiculæ seminales; but the triangular space within the bladder is of even more limited extent, measuring from the apex backwards about one inch and a half, and between the two posterior angles—at the orifices of the ureters—from that to two inches transversely. The surface of this space is smooth, the mucous membrane being somewhat thinner than elsewhere, and adherent to the subjacent texture; thus never presenting any little folds, even in an empty state of the bladder. But this area in the inferior fundus is the most sensitive portion of the whole interior. In front of the apex of the trigone a small transverse prominence appears—the *uvula vesicæ*,—formed by a thickening of the submucous tissue; this elevation is placed just before the middle lobe of the prostate, and projecting from below into the urethral orifice, it partly closes the aperture; and is sometimes continued forwards as a slighter elevation on the floor of the prostatic portion of the urethra. Adjoining the orifice of the urethra, the bladder becomes narrowed into a funnel-shaped portion—the *cervix* or *neck*—within which the mucous membrane is disposed in longitudinal folds. In the *female* the trigone is a smaller space, the muscles of the ureters are less developed, and the uvula is indistinct.

Size, Shape, Position, and Relations of the Bladder, as altered by the State of Distension.—The surgical anatomy of the bladder varies in certain important particulars, according to the state of collapse or distension of this organ. When entirely *empty*, after the complete evacuation of urine, it is reduced to its minimum size, and it then has the shape of a triangular sac, flattened in front and behind; its base is directed downwards, resting on the rectum, and the apex reaches upwards to behind the symphysis pubis, so that the sac lies against the triangular ligament, and is sunk down entirely within the cavity of the pelvis. When *moderately* distended—as was supposed in describing the relations of the bladder—this sac assumes a circular form, with the corresponding dimensions of about three inches in width and five inches in length,—the organ holding about a pint; but its axis remains nearly vertical, and it is still contained within the pelvis cavity. When *fully* distended, the bladder acquires an ovoidal or egg-shaped form, curved also somewhat, and compressed from behind forwards, thus becoming slightly concave in front and widened from side to side; the organ has rotated on its transverse axis, the base being directed downwards and backwards on the rectum or vagina, and the summit looking upwards and forwards,—its long axis, therefore, inclining in an oblique line drawn from the coccyx to some point between the pubes and the umbilicus; the bladder rises in the direction of this line, out of the pelvis, until its summit touches the wall of the abdomen above the pubes, in the hypogastric region, at a height varying according to the state of distension. This elevation of the bladder proceeds from the neck, which, owing to its true ligamentous attachments, and connection with the urethra, is a tolerably fixed point. The funnel-shaped outlet still remains the lowest portion in front, but it is elevated relatively to the prostate; the inferior fundus, also rising to a higher level, is relatively less dependent; while externally, the peritoneal pouch recedes to some extent from the base, thus presenting a larger triangular space against the rectum, and the summit of the bladder, in front of the superior peritoneal false ligament, is more exposed, or comes in contact with the wall of the abdomen above the pubes.

The *age* of the subject examined must not be overlooked in noticing the relative anatomy of the bladder.

In *infancy* and *youth*, the neck is the lowest portion of the bladder,—lower than the inferior fundus; the prostate, in front, around this portion, is of much smaller size or rudimentary; and the bladder lies partly in the cavity of the pelvis, but projecting upwards more or less above the brim into the hypogastric region.

In *old age*, on the other hand, the inferior fundus is even more capacious and dependent than in the adult, and any enlargement of the prostate will increase this proportionate difference; so that if the finger be introduced through the neck of the bladder, as in lithotomy, the fundus is felt inclining downwards, and as the prostate projects upwards, the finger must be hooked downwards to reach the fundus.

In the *female*, the prostate being absent, the inferior fundus is less relatively dependent below the neck of the bladder, but the capacity of the whole organ is perhaps larger than in the male; and its width from side to side is greater than its height from base to summit, which is the longer diameter in the male subject.

PROSTATE GLAND.—By an intimate association, both pathological and surgical, we are led from the anatomy of the bladder to consider the structure and relations of the prostate gland. We proceed therefore to notice, successively, the situation, shape, size, position, and relations of this organ; then, its structure; and lastly, the prostatic portion of the urethra.

The prostate, an organ peculiar to the male subject, is a firm glandular body, *situated* at the neck of the bladder, which it surrounds, and the commencement of the urethra passes through it. This body is placed deep in the cavity of the pelvis, and looking towards its outlet in the perineum; it lies below the symphysis pubis by half an inch or more, and behind the triangular ligament at its lowest part. Standing in front of the neck of the bladder, adjoining its base, the prostate thence derives its name (προΐστημι, to stand before); and beneath it rests on the middle portion of the rectum, just above the terminal portion,—about the depth of one inch and a half from the anus, where the bowel turns downwards to the anal aperture. Here, therefore, the prostate is accessible from the surface in the perineum. The shape and size of this body resemble the form and dimensions of a horse-chestnut. Its *shape* is that of a truncated cone, compressed from above downwards; the base being turned backwards to the bladder, and the blunt apex forwards to the triangular ligament and the membranous portion of the urethra. The anterior, or upper, surface—according to the position of the body—is somewhat convex, and marked by a slight median groove. The under surface is larger and flattened; it also presents a median furrow, thus indicating a division of the gland into two lateral lobes. The base of the prostate, its thickest part, is notched in the middle and under aspect of the gland; and this posterior notch receives the common ejaculatory ducts, above which, and in the interval between the lateral lobes, is placed a small rounded or triangular portion of the gland,—the third or middle lobe, transversely connecting the two lateral lobes, and which lies beneath the neck of the bladder, just behind the uvula and the adjoining commencement of the urethra. The sides of the prostate are convex, and the apex is truncated. In respect to the *size* of this body, it varies so much according to the age of the subject, that the average dimensions must be taken as found in the adult. The measurements in three different directions may thus be stated: from apex to base, one inch or rather longer; transversely at the base, its widest part, about one inch and a half; and in depth or thickness, about one inch or rather less. Consequently, an incision having an oblique direction downwards and outwards, from apex to base, in the lateral part of the gland, will be the longest section of which the prostate admits. But in infancy and youth, the gland is rudimentary or of small size; whereas, after middle life and in old age, it may undergo considerable enlargement. The weight of this body averages from half an ounce to an ounce; but this, like its size, varies with the period of life, and in different individuals of the same age.

The *position* of the prostate, or its attitude, must necessarily change, with the position of the pelvis,—in the recumbent or the erect state of the body. When recumbent, the pelvis has that position in which a line drawn through the prostate, from apex to base, would be directed obliquely downwards and backwards; the upper surface inclining backwards, and the lower surface somewhat forwards, the more so as the pelvis is elevated; and this corresponds with the position in which the prostate is generally submitted to surgical examination, or operation, in connection with the bladder. In the erect state of the body, the axial line of the prostate falls from the oblique to nearly a horizontal direction; and when the trunk is inclined forwards, so as to present the fundament backwards, the prostate, its under surface, turns with it in the latter direction,—thus corresponding to the position in which the gland may be examined with the finger through the rectum.

Certain *relations* of the prostate to surrounding parts have already been noticed incidentally, with reference to the neck of the bladder, the pelvic cavity, and the rectum. Thus, the base of the gland, around the neck of the bladder, receives also the common ejaculatory ducts, and it limits in front the triangular space which is free of peritoneum at the base of the bladder; the apex of the gland touches the triangular ligament and the membranous portion of the urethra, in the pubic arch, about an inch below the pubes; and its under surface rests upon, and is closely adherent to, the rectum, at its terminal portion, which then turns downwards to the anus. This under surface of the prostate and its base may be felt by introducing the finger through the anus into the bowel. The remaining surfaces have special relations to the recto-vesical fascia. Thus, the upper surface of the prostate, below the pubic symphysis, is covered by two strong, roundish bands, which form the anterior true ligaments of the bladder, with the dorsal vein of the penis lying between them; while the sides of the gland are covered by the broad and membranous lateral true ligaments of the bladder.

But in addition to these fascial prolongations, thus disposed, the remainder of the prostate receives an investment from the same fascia; forming altogether a complete sheath or capsule which envelops the gland. External to this capsule, the sides of the prostate are overlaid by the anterior fibres of the levatores ani muscles, one on each side, which passing down from the symphysis pubis, and spreading over the sides of the gland, unite together in front of the rectum, in the central tendinous point of the perineum, with the fibres of the external sphincter of the anus. Thus the prostate is slung by the levatores ani muscles, just as the rectum, and the vagina in the female, are also slung by these muscles; and these anterior portions of the muscular fibres, which are sometimes defined by a cellular interval, have been named *levatores prostatæ.* In old persons, the rectum may have become much dilated above the anus, forming a pouch, which rises up and wraps around either side of the prostate, so as to enclose this body, except at its upper surface.

The *structure* of the prostate gland was so far noticed in describing the shape of this organ, that it was seen to consist of three lobes: two lateral, of equal size, separated only by a median furrow on the upper and lower surfaces of the gland, and by a notch at the base; within which interval is placed the middle or third lobe. The mass of the gland, having this lobed arrangement, is encapsuled within a fibrous coat, consisting of two layers: an external dense layer, or an ensheathing prolongation from the recto-vesical fascia, as already mentioned; and an inner, thin, membranous investment, which sends processes into the interior of the gland, supporting its substance. Between these two layers of the *capsule*, a *plexus of veins*, the prostatic plexus, is enclosed. The substance of the gland has a reddish or brownish colour; its texture is spongy or firm to the touch, although not so dense as when felt through the fibrous coat, with perhaps also the thickness of the rectum intervening; and it yields or lacerates under pressure with the finger,—splitting in the direction of its grain, the prostatic ducts, as when, in the operation of lithotomy, the prostatic incision is enlarged by introducing the finger into the bladder. The glandular substance consists of numerous small terminal follicles, which, in the form of clusters, surround and open into the elementary ducts; these, having a branched arrangement, unite into the excretory ducts, about twelve to twenty in number, which open by as many orifices upon the floor of the prostatic portion of the urethra. The epithelium in the follicular terminations is squamous, and in the ducts, columnar. Section of the gland shows the ducts, which appear as white lines or minute apertures, according to the direction of their division. Richly supplied with blood-vessels, the arteries are branches of the vesical, hæmorrhoidal, and pudic arteries, which, passing into the substance of the gland, ramify and form a capillary network around the ducts and clusters of follicles; the prostatic veins form a plexus around the gland, between the two layers of its fibrous capsule, and this venous plexus communicates in front with the dorsal vein of the penis, but behind with the plexus of veins at the neck, base, and sides of the bladder, thence passing into the internal iliac veins. This continuous plexus of veins—prostatic and vesical—becomes enlarged in old subjects, and is often the source of troublesome hæmorrhage when wounded in lithotomy. Lymphatic vessels, with the veins, ramify beneath the dense external layer of the fibrous capsule. Nerves are derived from the pelvic hypogastric plexuses on either side of the bladder, prolongations from which form the *prostatic plexus of nerves.*

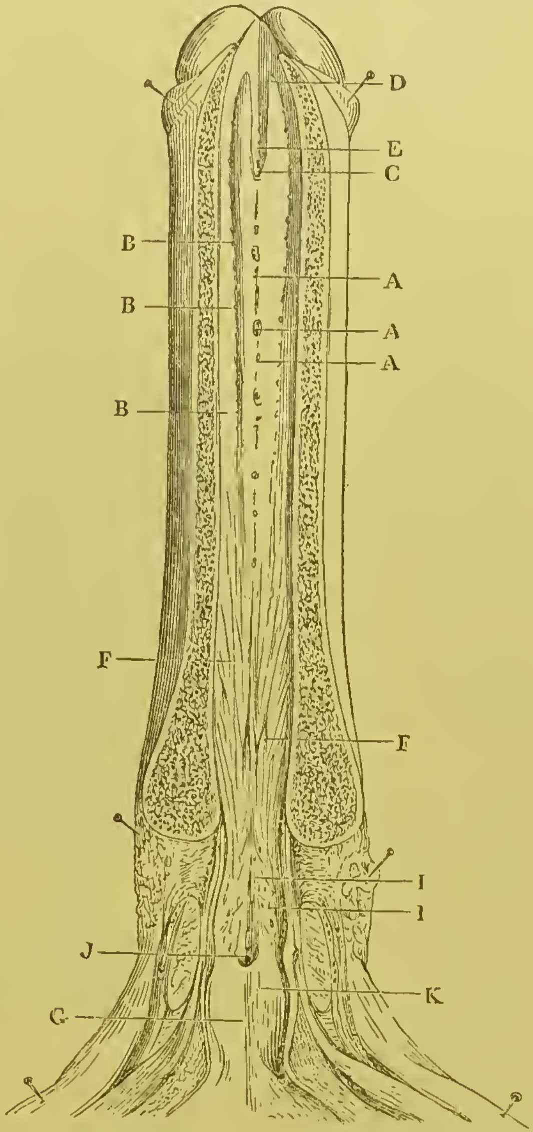
The *prostatic fluid*, or secretion of the gland, mixed with the seminal fluid, is discharged in the act of emission. But the nature of this fluid, in itself, is not well known. After death, when fresh, it has a milky white tint, an acid reaction, and abounds with granular matter and epithelial particles, squamous and columnar.

Urethra.—The urethra is a membranous tube, which extends from the neck of the bladder to the end of the penis. The length of this tube averages nine or ten inches, when the penis is flaccid, but admits of some elongation during erection of this organ; the size of the tube varies in different parts, being about a quarter of an inch in its widest part—the centre of the prostate. The urethral tube consists of mucous membrane, with an outer layer of submucous cellular and elastic tissue; but it is supported also by the structures through which it passes, and by certain muscular expansions. Lying in the middle line, the urethra passes from the bladder through the substance of the prostate gland; then, becoming simply membranous, the tube penetrates the triangular ligament, under the arch of the pubes; and then entering the spongy structure of the penis, it is continued to the end of the glans and opens externally as the *meatus urinarius.* The *direction* of the urethral canal, in its course forwards, is that of a double curve; the prostate and membranous portions, and the commencement of the spongy portion, or its bulbous part, together form a curve, downwards, forwards, and upwards to the front of the pubes; from which point the remainder of the spongy portion descends in the penis. This double curve, however, depends upon the state of the penis; for when this organ is erect, or raised upwards towards the pubes, the second curve forms with the first a single curve, thus continuing the concavity of the curve upwards,—as in passing a catheter. The urethra performs the excretory function of transmitting and discharging the urine from the bladder; but it also transmits the seminal fluid in sexual intercourse.

The three portions of the urethra, already indicated, severally demand a separate notice.

The *prostatic* urethra is that portion of the tube which extends from the vesical orifice to the membranous portion, about a line behind the triangular ligament,—its posterior layer. This portion of the urethra passes through the prostate gland, from base to apex; lying at first above the middle lobe, and afterwards nearer to the upper than to the lower surface of the gland, by about two-thirds of its substance below

Fig. 853.*



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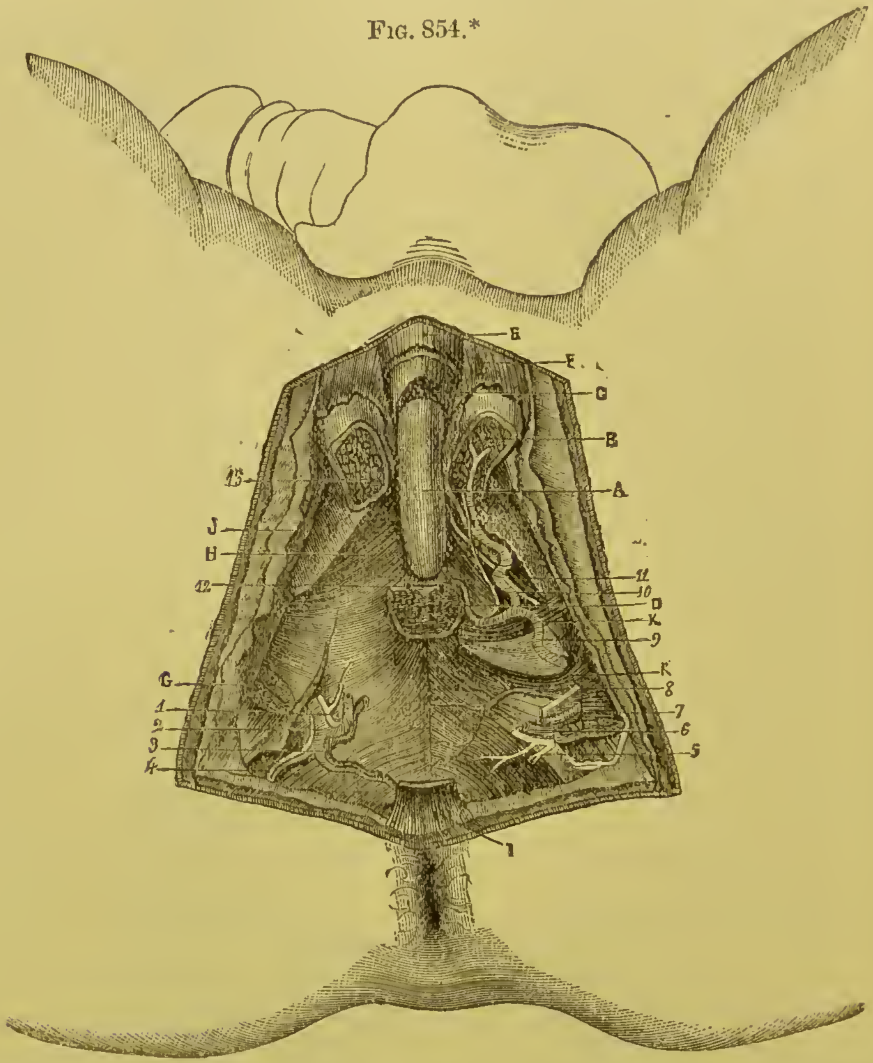
* The mucous membrane of the Urethra, in Male.—A, A, A, lacunæ (of Morgagni); B, B, B, foraminulæ (openings of minute glands); C, fold of mucous membrane forming a sort of valve to the fossa navicularis; D, prolongation of the corpus spongiosum, forming the glans; E, lacunæ in the fossa navicularis (lacuna magna); F, F, longitudinal folds of mucous membrane, effaced upon dilation; G, caput gallinaginis, or verumontanum; I, I, orifices of the glands of Littré (small racemose mucous glands and follicles); J, sinus pocularis; K, mucous glands in the prostatic sinus of the urethra. (After Jarjavoy.)

the urethra. The common ejaculatory ducts also converge under the base of the prostate, forwards and upwards, lying side by side for about an inch, between the middle and lateral lobes, and then pass through the gland to open on the floor of the prostatic urethra. This portion of the urethra has a fusiform or spindle shape, being widest in the middle, and constricted somewhat before and behind. (Fig. 853.) Its length is about one inch and a quarter. Its breadth behind, at the neck of the bladder, is about a quarter of an inch; in the middle, it widens to a line or two more; and in front, at the commencement of

FIG. 854.*



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* Deep view of the Perineum, in Male.—A, Urethra; B, crus penis (cut); C, bulb of urethra (cut); D, posterior part of bulb; E, bulbo-cavernosus or accelerator urinæ (cut); F, ischio-cavernosus or erector penis (cut); H, triangular ligament of urethra; I, external sphincter (cut); J, aponeurotic insertion of erector penis into crus penis; K, K, compressor vel constrictor urethræ muscle. 1. Superficial perineal nerve. 2. Superficial perineal artery. 3. Superficial perineal vein. 4. Vessels and nerves (unnamed) passing backwards, and coming from superficial branches. 5. Anal branch of superficial perineal nerve (communicates with the inferior hæmorrhoidal). 6, 7, 8. Trunks of superficial perineal vessels and nerves. 9, 10. Internal pudic artery. 11. Internal pudic vein. 12. Artery to the bulb (cut), from the superficial perineal. 13. Artery of the corpus cavernosum, from the internal pudic (cut). (After B. J. Béraud.)

the membranous urethra, the canal narrows again to rather less than behind. It is the widest and most dilatable portion of the whole urethral canal, although least extensible at the neck of the bladder. The mucous membrane of the prostatic urethra presents slight longitudinal folds, in a collapsed state of the passage; but a median ridge of mucous membrane and thickened submucous tissue projects in the floor of the urethra; extending from just in front of the little elevation—uvula vesicæ—at the vesical orifice, and, gradually rising to a peak, it subsides rather abruptly towards the membranous urethra. This ridge is about three-quarters of an inch in length, but only a line and a half in depth, at its highest point. It is variously named; the *crest* of the urethra, or *crista urethræ;* more commonly, *caput gallinaginis*, and *veru montanum.* On either side lies a depressed portion of the canal, the *prostatic sinus*, in the form of a longitudinal groove, and somewhat deeper behind at the vesicle orifice; the floor of either sinus is beset with numerous small apertures, the openings of the prostatic ducts from the lateral lobes, while those of the middle lobe open behind the central crest. In the crest, just in front of its peak, a small recess or *cul-de-sac* passes downwards and backwards between the lateral lobes, and beneath the middle lobe; at its orifice in the urethra, this *cul-de-sac* is about a line in width, but it enlarges to double that size at its fundus, a depth of about a quarter of an inch. This recess in the central crest is usually named the *sinus pocularis;* also the *vesica prostatica*, or the *utricle*, as being probably the analogue of the uterus in the female. It receives the two common ejaculatory ducts, which open by two narrow slit-like apertures upon or within the margins of the *cul-de-sac*, one on either side, or sometimes at the bottom of the fundus. Numerous small glands also open within this recess; and the crest has been found to contain erectile tissue, whereby, perhaps, when distended with blood, this central eminence may prevent any retroversion of semen into the bladder.

The *membranous* urethra reaches from the apex of the prostate to the bulb of the corpus spongiosum. It passes through the double membranous layer of the triangular ligament in the pubic arch, about an inch below the symphysis (Fig. 854), but this portion of the urethra extends backwards for about a line behind the ligament, to the apex of the prostate, and forwards, a little in front, to the bulb. Having a curved direction upwards, the greatest length of the membranous urethra measures not more than three-quarters of an inch in the convavity; the convexity is even less, being overlaid by the bulb in front; and its diameter is less than that of any other portion of the urethra. The tube here lies over the end of the rectum, but separated by a cellular interval, where the bowel turns downwards; above, the dorsal vessels and nerve of the penis penetrate the triangular ligament; between the two layers of this ligament, the membranous urethra is embraced by the *compressor urethræ* muscle, consisting of two layers of transverse muscular fibres, one above and one below the tube, attached to the ramus of the pubes on either side, and some circular muscular fibres surround this part of the urethra. Just beneath, and under cover of the lower band of fibres, are situated Cowper's glands; two little bodies, like peas, of a yellow colour, one on either side. Above, lie the arteries of the bulb, one on either side,—about half an inch above the base of the ligament.

The *spongy* portion of the urethra extends from the membranous part, at the bulb, to the external orifice, at the end of the glans penis. Continuing the curve of the membranous urethra up to the symphysis pubis, and then descending in the pendent penis, on its under surface, this portion of the urethra is enclosed in the corpus spongiosum. It is the longest portion of the whole urethra, measuring six inches, more or less, according to the length and state of the penis; its diameter is somewhat dilated in the bulb,—as the *bulbous sinus*, and again in the glans,—forming the *fossa navicularis;* and in both these parts, the floor of the passage is most dilated. In the interval between these dilatations, the spongy urethra is of smaller size, about three lines in diameter; and at the external orifice, the urethra is even more contracted, that being the narrowest point of the whole tube.

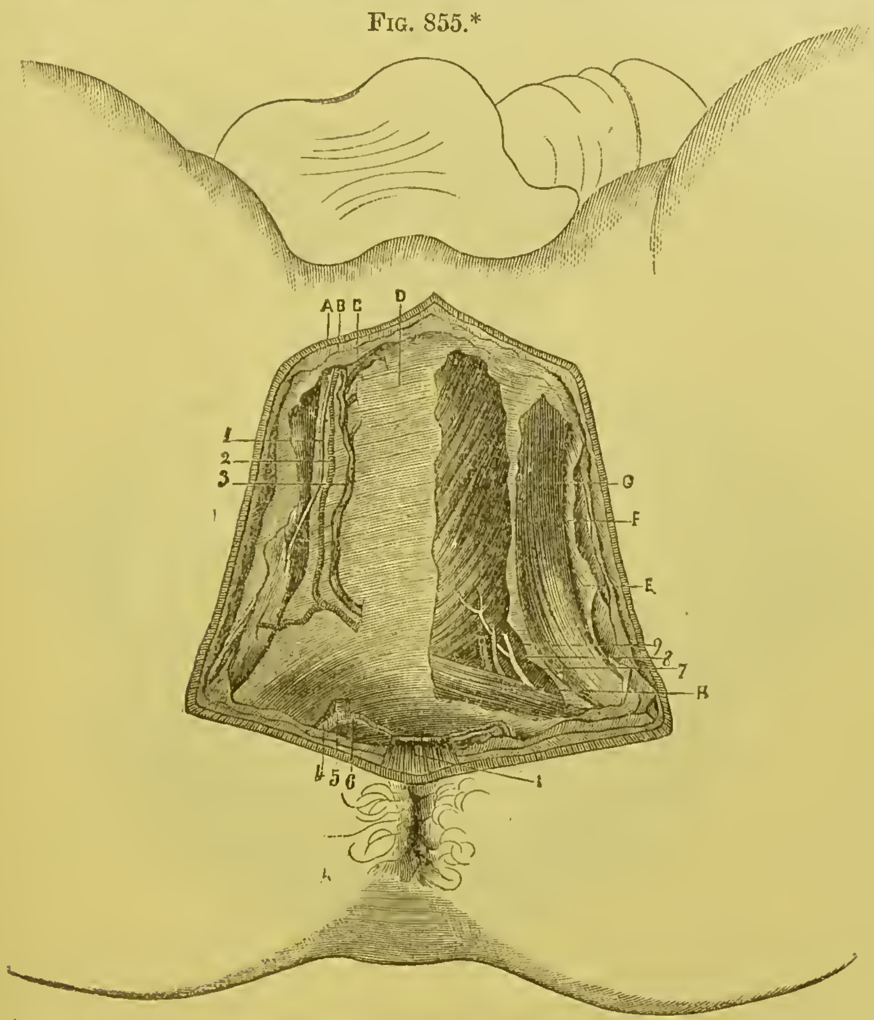
In the course of the urethral canal, it should be observed that its size or *diameter* varies. There are *three dilated* parts—the *prostatic* sinus, the *bulbous* sinus, and the *fossa navicularis* in the glans penis; and of these, the first named is the widest part of the whole canal. Other parts are more or less narrow, and the narrowest is the external orifice in the glans. The *form* of the canal is of less practical consequence, but a section differs also in different parts of its extent; in the prostate, it has a triangular shape, with the apex downwards; in the membranous and spongy portions of the passage, a transverse opening,—except in the glans, and at the urethral orifice, which presents a vertical fissure opening,—*meatus urinarius.*

The *mucous membrane* of the urethra is a prolongation of the genito-urinary; being continuous with that of the bladder, ureters, and kidneys, and with offsets lining the prostatic and ejaculatory ducts. The ducts of Cowper's glands pass forward—in the membranous portion, beneath the mucous membrane, to the extent of an inch or more, and open by two oblique pin-hole apertures, in the floor of the bulbous portion of the urethra, at its fore part. The urethral mucous membrane has a reddish colour, but is paler in the prostatic portion. Throughout its course this membrane is loosely connected by submucous tissue to the corpus spongiosum or erectile structure which encloses the tube; so that the mucous surface of the membrane presents longitudinal folds, which, however, are effaced when the canal is distended during micturition or by the passage of an instrument. Numerous mucous follicles and lacunæ stud the surface, especially along the *floor* of the urethra, and in the bulbous part; but the largest—*lacuna magna*—is situated in the fossa navicularis, on its upper surface. These openings are directed forwards, towards the outer urethral orifice; a larger one than usual may, therefore, offer some hitching impediment to the passage of a small-sized instrument along the urethral canal.

The *corpus spongiosum* is that erectile structure which surrounds the urethra, from the end of the membranous portion to the external orifice of the urethra. Commencing just in front of the triangular ligament,—rather behind the converging crura of the corpora cavernosa, which chiefly form the body of the penis,—the corpus spongiosum appears in the shape of a flattened ovate extremity—the *bulb*, projecting backwards beneath the membranous urethra, in front of the triangular ligament. Continued forwards as a cylindrical investment of the urethra, the corpus spongiosum lies in a groove or furrow on the under surface of the corpora cavernosa, at their junction in the middle line; but at their anterior truncated end, the spongy body enlarges over them and forms the glans penis. Around the vertical orifice of the urethra, the erectile structure forms two small lips, which when turgid with blood—as from congestion of the mucous membrane—constrict the urethral orifice to a smaller size than even in its usual state.

The *muscles* of the urethra and penis are—the accelerator urinæ or ejaculator seminis, the compressor urethræ, already noticed, and the erector penis.

FIG. 855.*



The *accelerator urinæ* has an important relation to the urethra. This muscle is a flat expansion of muscular fibres, under and around the urethra, or corpus spongiosum, and extending from the bulb to the junction of the corpora cavernosa, at the converging crura. (Fig. 855.) The muscle arises from the central tendinous point of the peritoneum, situated just behind the bulb of the urethra—a point which also gives attachment to the sphincter ani, and to the two transverse muscles of the perineum; from this point, a tendinous raphé, in the middle line, gives rise to fleshy fibres, thus forming a symmetrical bipartite muscle, which overlies the bulb and adjoining part of the corpus spongiosum. The two halves of the muscle, for the most part, pass round the spongy urethra, and are united above by a tendinous aponeurosis; but a band of anterior fibres, on either side, embraces the corpus cavernosum, at the junction of the crus, and are inserted into a fascia on the dorsum of the penis, over the dorsal vessels and nerve. The action of the urethral portion of this muscle is to expel any fluid, urine or semen, from the urethra, at the same time aiding in maintaining the turgescence of the glans penis; while the two penile bands of fibres will aid in maintaining the erectile state of the whole organ.

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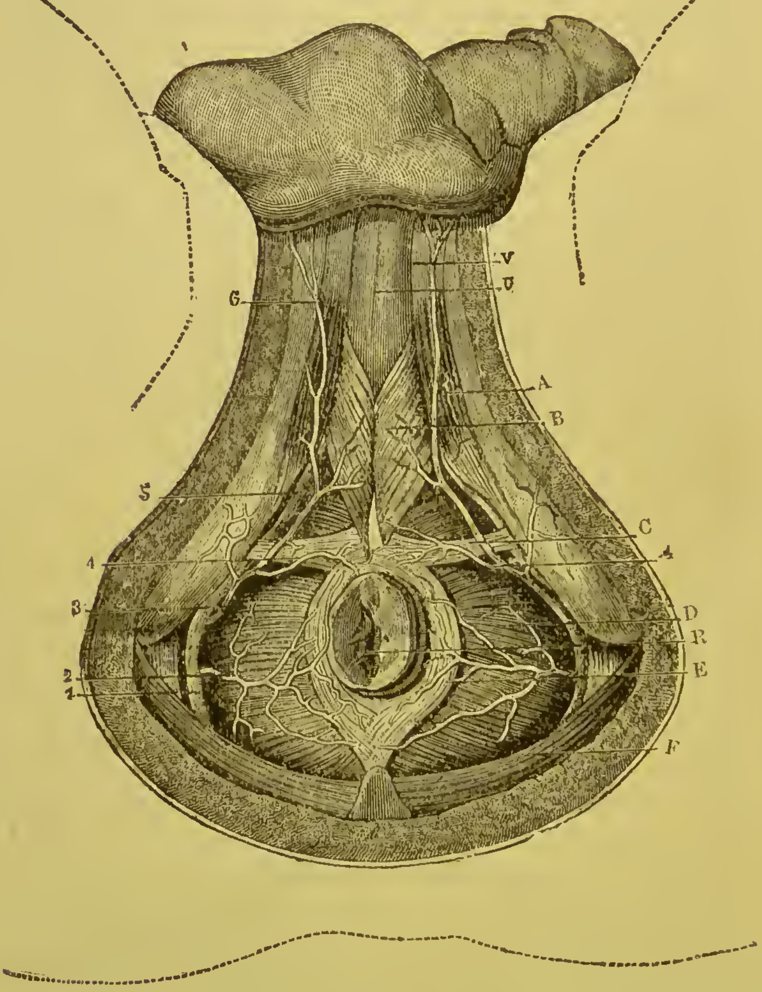
* Superficial view of the Perineum, in Male.—1. Superficial perineal nerve. 2. Superficial perineal artery. 3. Companion vein. 4. Hæmorrhoidal vein. 5. Inferior hæmorrhoidal branch of artery. 6. Inferior hæmorrhoidal nerve. 7, 8, 9. Superficial perineal vessels and nerve (cut). A, skin; B, subcutaneous superficial fascia; C, deep fascia; D, triangular ligament; E, sheath of crus penis; F, ejaculator urinæ; G, erector penis; H, transversalis perinei muscle; I, external sphincter ani muscle (cut). (After B. J. Béraud.)

FIG. 856.*



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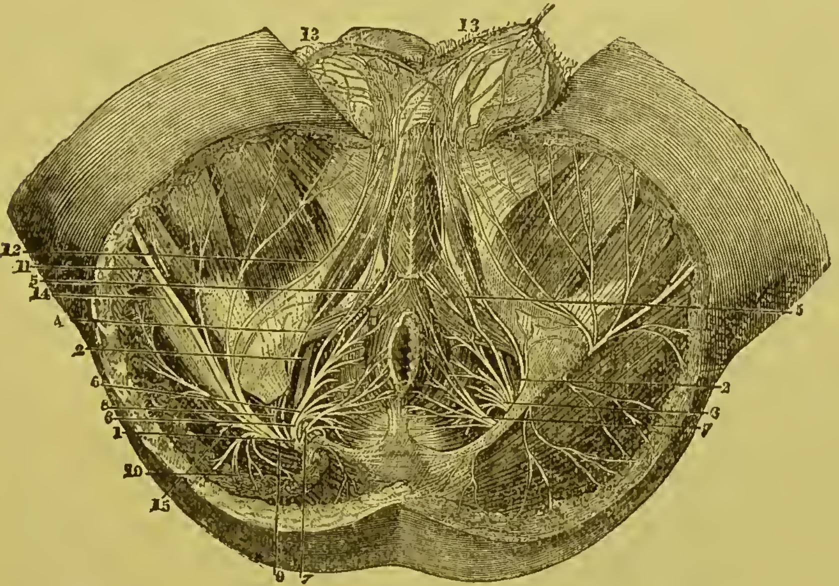
* Arteries of the Perineum, in Male.—V, corpus cavernosum; U, urethra; R, anus; A, ischio-cavernosus or erector penis muscle; B, bulbo-cavernosus or accelerator urinæ; C, transversus perinei; D, levator ani; E, external sphincter of anus; F, gluteus maximus. *Arteries:*—1. Trunk of internal pudic. 2. Inferior hæmorrhoidal. 3. Superficial perineal. 4. Transverse perineal. 5. Dorsal artery of penis. 6. Terminal branches of superficial perineal. (From A. Jamain.)

The *arteries* of the penis are branches of the internal *pudic* artery (Fig. 856), namely, the two arteries of the bulb, distributed to the erectile structure of the corpus spongiosum; the dorsal artery, supplying the glans penis; and the two arteries of the corpora cavernosa, distributed to the erectile structure of these bodies, which constitute the body of the penis. The arterial vessels having penetrated the fibrous coat of the spongy and cavernous bodies, they ramify as a capillary network, supported by fibrous prolongations from the sheath, or trabeculæ; which, in the shape of bands and cords, in all directions across the sheath, leave inter-trabecular spaces. A median fibrous partition—*septum pectiniforme*—separates the two corpora cavernosa; but the comb-like clefts of this septum, passing from the dorsal to the urethral margin, allow a free vascular intercommunication, except at the root of the penis, where the septum is entire. Companion *veins* to each of the two pairs of arteries form plexuses, which occupy the inter-trabecular spaces in the spongy and cavernous bodies; but the veins in the spongy structure do not communicate with those of the cavernous structure. The inter-trabecular veins, for the most part, emerge from the bulb and cavernous bodies at the root of the penis, and enter the prostatic plexus; while the dorsal vein, coming from the glans, and lying with the artery in the groove on the back of the penis, also enters the prostatic plexus.

FIG. 857.*



Lymphatics proceed from the urethral mucous membrane, that of the glans also, and from the skin of the prepuce, as a network, from which emergent vessels enter the inguinal lymphatic glands; but some *deep* lymphatics, from the spongy and cavernous bodies, pass under the pubic arch to the lymphatics in the pelvis.

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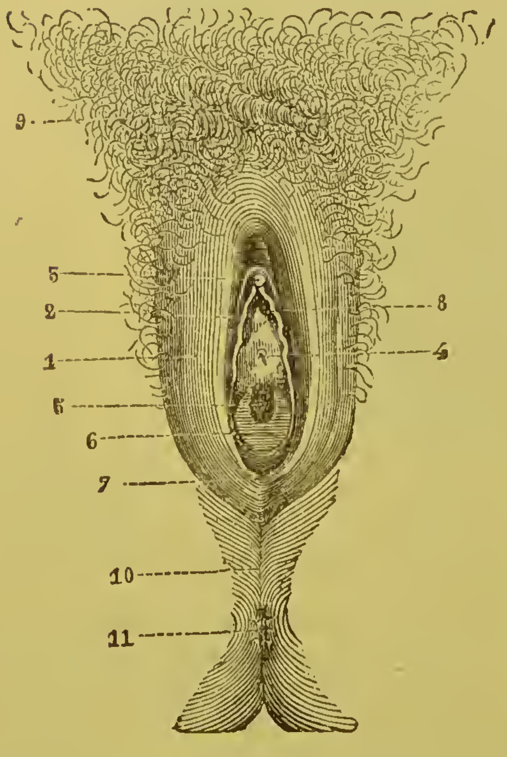
* Perineum, in Male; showing nerves.—1. Internal pudic. 2. Dorsal nerve of penis. 3. Perineal nerve. 4. External superficial perineal branch. 5. Internal superficial perineal branch. 6. Musculo-bulbal nerve. 7. Inferior hæmorrhoidal. 8. Nerve to internal obturator muscle. 9. Small sciatic nerve. 10. Muscular of small sciatic to gluteus maximus. 11. Genito-crural. 12. Inferior pudendal nerve, 13. Nerves of diartos (network of inferior pudendal on scrotum). 14 Great sciatic nerve. 15. Nerve to pyriformis muscle. (After Hirschfeld and Léveillé.)

Nerves are supplied to the penis, corresponding to the arteries. They are derived from the *pudic* nerve, a branch of the sacral plexus of spinal nerves; and from the *prostatic plexus*, an offset of the hypogastric plexus of the sympathetic. Thus, from the *pudic* nerve (Fig. 857) proceeds the dorsal nerve, distributed to the glans, but also supplying a large branch to the corpus cavernosum on each side, and integumental branches to the prepuce, dorsum, and sides of the penis. The two superficial perineal nerves, from the perineal branch of the pudic nerves, supply the under surface of the penis; and from the same source also are derived muscular branches to the accelerator urinæ, and to the erector penis, as well as a branch to the transverse muscle of the perineum. The pudic nerve likewise gives off the nerve of the bulb, which is distributed to the corpus spongiosum, around the urethra. But the prostatic plexus of the sympathetic nerve supplies an offset to the corpora cavernosa, some cavernous filaments also penetrating the corpus spongiosum; and these cavernous nerves communicate with the dorsal nerve of the pudic.

Female Urethra.—In the female, the urethral canal is shorter, wider, and straighter than in the male. Averaging in length only one inch and a half, its diameter is a quarter of an inch or more, but enlarged and funnel-shaped adjoining the neck of the bladder, narrowed at the external orifice, with a dilatation in the floor of the urethra near the meatus. The course of this canal is nearly straight, having a slight curve below the symphysis pubis, the concavity looking upwards.

FIG. 858.*



Lying in the middle line, the urethra passes from the bladder through the triangular ligament, in the pubic arch, to the external orifice; but, throughout its course, the tube is imbedded in the texture of the upper or anterior wall of the vagina, the compressor urethræ muscle embraces it in the arch of the pubes, between the two layers of the triangular ligament, and behind this structure the anterior ligament of the bladder overlies the vesical portion of the tube. Owing, however, to the comparative absence of unyielding structures around the urethral tube, it admits of dilatation much more readily than the male urethra. The external orifice, or *meatus urinarius*, is a small, round opening, set in an elevation; it is situated within the vulva, immediately above the entrance to the vagina, and below the symphysis pubis, about an inch beneath and behind the clitoris, and between the commissure of the inner, smaller labia, or nymphæ. (Fig. 858.)

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* External genitals, in Female. 1. External labia. 2. Internal labia or nymphæ. 3. Clitoris. 4. Meatus urinarius. 5. Opening of vagina. 6. Hymen. 7. Fourchette. 8. Vestibule. 9. Mons veneris. 10. Perineum. 11. Anus. (From A. Jamain.)

The urethral tube consists of mucous membrane, with an outer layer of submucous cellular and elastic tissue, enveloped by a vascular structure containing a plexus of veins. The mucous membrane has a pale colour, except adjoining the external orifice; and it presents longitudinal folds,—one more especially, in the floor of the canal, which corresponds to the median crest in the prostatic portion of the male urethra. Numerous tubular mucous glands lie between the folds of membrane, with their apertures directed towards the bladder; and mucous follicles open within and around the outer orifice of the urethra. Both these forms of gland are of larger size towards the more external portion of the tube. The *vessels* and *nerves* proceed from those which supply *the vagina.*

INJURIES OF THE BLADDER.

The *Bladder*, lodged within the bony walls of the pelvis, is less liable than many other organs to external Injury, as wounds or rupture; and only occasionally to the intrusion of foreign bodies from without, through the urethra or by gunshot penetration; but it is very commonly the receptacle of urinary concretions or Calculi, and it is subject to various Diseases, principally inflammation and morbid growths or tumours. This organ is also specially prone to Functional Disorders; *e.g.*, irritability of the bladder, arising from numerous causes, local and constitutional.

These lesions, diseases, and disorders severally demand the attention of the Surgeon, in regard to their special pathology and treatment.

Laceration of the bladder happens not unfrequently with fracture of the pelvis, this additional injury being a most serious complication in consequence of the extravasation of urine. An open wound, as by a bullet, may allow the urine to escape freely, externally; and recovery has then been known to result. Several such cases are related by Guthrie and by Thomson as having occurred at the battle of Waterloo. *Rupture* of the bladder is also not uncommon, as caused by blows, kicks, or contusions on the lower part of the abdomen; especially when the bladder is fully distended and rises above the pubes in contact with the abdominal wall. Thus, this accident may happen from a fall in wrestling, the uppermost man coming down upon his antagonist; or from running against a post in the dark, an instance of which is related by Liston. In that case a large calculus, which occupied the bladder, was shattered into fragments by the concussion.

The *effects* of laceration or rupture of the bladder vary according to the seat of injury, as above or below the reflection of the peritoneum; whereby extravasation of urine takes place into the peritoneal cavity, or into the cellular tissue of the pelvis. In the one condition, fatal peritonitis speedily ensues; in the other, diffuse inflammation is followed by sloughing of the cellular texture of the pelvis and abdominal wall as infiltration proceeds, and a less speedy termination.

The *symptoms* of ruptured bladder are obvious; sudden and intense burning pain, in the hypogastric region, with immediate collapse, and inability to pass water, or a little bloody urine coming away through the urethra. On introducing a catheter, the bladder is found to be empty, or a small quantity of bloody urine is drawn off. In gunshot wound implicating the bladder, the urine may perhaps be seen to escape through the track of the wound.

Treatment.—Extravasation should be immediately prevented extending further, by the introduction of a full-sized gum-elastic catheter into the bladder—which is retained by means of tapes—that the urine may dribble away as fast as it descends into the bladder. Any appearance of extravasation presenting externally must be at once met by free incisions, so that the infiltrated fluid shall escape, and sloughs also as they form. By this prompt prevention of further extravasation and arrest of the diffusive inflammation in the cellular texture, a circumscribing barrier of lymph may be thrown out, and life be preserved. Peritonitis, consequent on extravasation into the peritoneal cavity, may also be diminished by using the catheter as directed, but the fluid already imprisoned within the peritoneum will still maintain the inflammation. The general treatment consists in the administration of opium and stimulants, with whatever nourishing food can be taken to support the patient through the subsequent exhaustion, especially in the process of sloughing.

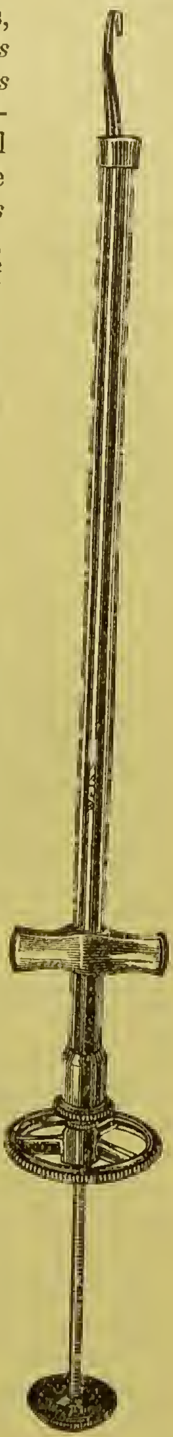
Rupture of Ureter.—This rare form of injury has been known to happen from external violence, and recovery in one instance at least. In a case which Mr. Stanley has recorded, a large accumulation of fluid formed around the seat of injury, with considerable circumscribed swelling and fluctuation, which was repeatedly tapped. Ruptured pelvis of the ureter, in another case, led to the formation of a similar cystic collection of urine behind the peritoneum; and no less than six pints of urine were drawn off by tapping, at one sitting. Death occurred about ten weeks after the accident.

Foreign Bodies.—Various foreign bodies, such as portions of catheters, or bits of pencil or tobacco-pipe, are occasionally thrust into the bladder, through the urethra. Any substance, thus introduced, is usually of some length, and lying perhaps across the bladder, is rarely expelled in passing water; it must therefore be extracted surgically. This may sometimes be done with a lithotrite, by catching the body in the direction of its long axis, or by crushing the substance, as a stone; but sometimes it has been found necessary to have recourse to the operation of lithotomy. Knowing the size and shape of the foreign body, the median operation can be more frequently selected. Bullets, bits of clothing or other bodies, are occasionally lodged in the bladder by gunshot wound, implicating this organ. Any such body must be removed in like manner. In fifteen cases, which Mr. Dixon has collected, the ball had entered the bladder, either primarily, or in consequence of abscess and ulceration after having lodged near this organ; and, in ten of these cases, the ball was removed by the operation of lithotomy, with successful results. Of the remaining five cases, the termination is not recorded.

In the *female*, foreign bodies can be removed more readily from the bladder, owing to the urethra being of larger size and more dilatable, while the shorter extent and straighter course of the passage also facilitates extraction. An instrument, made by Weiss (Fig. 859), is specially suitable for catching and withdrawing a hair-pin.

In all cases, a foreign body in the bladder soon becomes encrusted with urinary deposit; and by thus increasing the difficulty of its extraction, and as a persistent source of irritation, inducing an unhealthy state of the bladder, the result of any operative procedure might be unsuccessful.

FIG. 859.



Worms of various species have, in rare instances, been discharged from the urinary bladder. The *Ascaris lumbricoides* or round worm, and the *Ascaris vermicularis* or thread-worm, both of which species inhabit the intestine, may escape into the bladder through a recto-vesical fistula. The *Strongylus gigas*, occasionally infesting the kidney, passes down the ureters. The *Spiroptera hominis* of Rudolphi, probably the young of *Strongylus gigas*, were discharged from the bladder, during a period of years—1806 to 1837—in a patient mentioned by Mr. Lawrence; and many of the *Dactylius aculeatus*, a small round worm, were voided from the bladder of a female child, in a case contributed by Mr. Curling. *Hydatids* also have been known to pass per urethram, in rare cases, recorded by Dr. Sieveking and Mr. Simon.

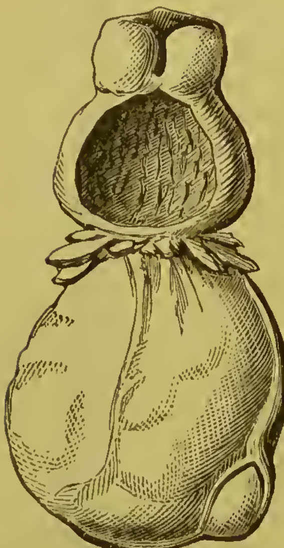
Displacements.—Under this title I propose to notice briefly two forms of Displacement which, as relating to the Bladder, are occasionally met with in practice—Prolapsus, and Hernia.

Prolapsus may occur in females, the bladder falling down with the anterior wall of the vagina, in the form of a rounded swelling within the labia, or perhaps appearing externally between the thighs. This tumour is soft and fluctuating to the touch, especially when pressure is made above the pubes; and the transverse rugæ of the vagina may be seen, unless the swelling be more tense. The compressible character, and the size of this vaginal swelling, will vary with the more or less distended state of the bladder; and after micturition, only a lax condition of the vaginal wall may remain. Passing the finger on to behind the tumour, the os uteri may be felt, having a direction downwards and backwards; and this uterine retroversion arising from the bulging tension of the vaginal wall, in front, there can be no doubt that the case is not one of prolapsus uteri, and which is a more common affection. Prolapsus of the bladder is attended with some bearing-down sensation,—stretching even from the navel, when the bladder is full; and constant vesical irritability urges to frequent and straining micturition, but with incomplete effect, as the fundus of the bladder still remains full; and while repeated efforts gradually increase the prolapsus, partial retention of urine at length provokes chronic cystitis. Surgical relief is sought sooner or later, for the bladder is not quiet in any state; whether moderately full or partly emptied. A catheter is introduced, and then—in addition to the vaginal tumour and vesical symptoms—the Surgeon can plainly feel the point of the instrument in the vagina, when turned down into the fundus of the bladder; and from which receptacle a quantity of urine may be drawn off, below the level that the patient could expel. By tilting up the vaginal wall with the fingers, the bladder is readily emptied; and this natural mode of relief, aided by an inclined position forwards, the patient may herself have learnt by experience.

The *cause* of this prolapsed state of the bladder is soon discovered. The patient has a large, relaxed vagina; which may be the result of anything that has impaired the natural tone of the passage. Commonly arising from repeated pregnancy, and tedious or difficult labour, this state of the parts is found mostly in women who have borne many children, and in rapid succession. Sometimes also, in women who are weakly and subject to leucorrhœa, the vagina is naturally so lax that prolapsus of the bladder seems to be ever impending. But a naturally lax *perineum*, which readily yields under any straining effort, is, so far as I have observed, rather a protective support against the descent of the bladder, or, indeed, of the uterus.

Hernia of the bladder, alias *Cystocele*, is a displacement of very rare occurrence. The protrusion may take place in either of the ordinary situations, as *inguinal* (Fig. 860) or *femoral* hernia; but it has been met with also as a *perineal* hernia. A tumour of a softened compressible character appears, say in the groin, and descends into the scrotum; thus resembling an intestinal protrusion—an *enterocele*. But certain peculiar and distinctive symptoms may be observed. The size of this swelling is scarcely affected by coughing—and which gives only a slight impulse—nor by the position of the patient, standing up or lying down; the swelling varies in size as the bladder is emptied, and fills again. On compressing the tumour during the act of micturition, or with a catheter in the bladder, the *quasi*-intestinal protrusion subsides; but it returns with the re-accumulation of urine. The unaided act of micturition may not reduce the swelling, for the protruded portion of the bladder still remains full of urine; and this partial retention is attended with incessant vesical irritability, and frequent desire to pass water—another symptom which distinguishes cystocele from intestinal hernia. A *scrotal* cystocele may simulate hydrocele—both are fluctuating tumours; but hydrocele is irreducible, except when congenital, and then the transparency of the distended tunica vaginalis *may* contrast with the opacity of a protruded bladder.

Fig. 860.*



Vesical hernia seems to originates in a relaxed and enlarged state of the bladder—an atonic condition, coupled with the retention of urine. The distended bladder yields laterally more readily than in any other direction, and thus reaching the internal abdominal ring, it may partly protrude through the inguinal canal. At first, there is no peritoneal investment—no sac; but when the fundus of the bladder descends, the peritoneal covering presents a sac. Sometimes, an ordinary intestinal and omental hernia coexists, and this protrusion descends in front of the cystic, behind which lies the spermatic cord. In some cases, the protruded portion of the bladder has contained not only urine, but also one or more calculi. With any symptoms of stone, sounding then, of course, will not detect the calculus. When situated in the groin, as a cystic bubonocele, the stone has been mistaken for a bubo; an odd mistake, considering all the different circumstances of the two cases.

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* St. Mary's Hospital Mus., H. *k*. 1. Hernia of bladder. The large herniated pouch was contained in a scrotal hernia, and it communicates above, by a constricted neck, with the pouch of the bladder, of smaller size, which was retained in the pelvis by its attachments to the enlarged prostate—shown at the upper part of the figure. The patient was never able to empty his bladder without compressing the large scrotal pouch, so as to force the urine up into the pelvic portion of the bladder. (Samuel Lane.)

The *treatment* of cystocele is simply that of hernia; the protrusion should be reduced, and kept up by a truss; or, when irreducible, a suspensory bag must be worn.

In the event of an operation, the Surgeon will remember the peculiarities of the hernia with which he has to deal;—the absence, usually, of a peritoneal sac to the bladder; and the possible coexistence of an intestinal hernia, with a sac, overlying the cystocele. Should the vesical protrusion contain a stone, this should be returned into the cavity of the bladder, and afterwards removed by lithotomy or lithotrity. But a stone has been extracted by direct incision into the protruded portion of the bladder, and no unfavourable symptoms followed this method of operation.

URINARY DEPOSITS.

Before proceeding to the consideration of Stone in the Bladder, and the treatment by Lithotomy or Lithotrity, it is necessary to acquire an elementary knowledge, at least, of the various Morbid Conditions which the Urinary secretion may undergo, and the formation of Deposits and Calculi. Apart from this relationship, the Student should possess such knowledge for the clinical investigation of very many other Surgical diseases, and in order to estimate the probability of recovery after most Surgical Operations.

MORBID CONDITIONS OF THE URINE are—either increased or diminished proportions of its normal constituents, or new adventitious ingredients; those, perhaps, of most practical importance being sugar, albumen, and bile.

In common with its healthy conditions, morbid conditions of the urine are immediately referable to corresponding causative conditions of the blood; but their pathological *origin*—like unto the physiological production of the urinary constituents—within the body, is remote.

MORBID CONDITIONS OF THE BLOOD.—In health, the composition of the blood is ever changing, by the addition of new matter, received through the process of digestion,—the primary assimilation of food; and as effete matter or waste of the textures, through their destruction in the course of nutrition,—secondary assimilation; and, furthermore, ever changing, by the abstraction of old, effete matter,—or excretion through the kidneys, skin, liver, and other excreting or secreting organs.

So likewise, in various diseases, the composition of the blood is ever changing by the addition of new morbid matter, through primary *mal*-assimilation, or secondary *mal*-assimilation, or by the co-operation of both these perversions,—the former representing that of digestion, the latter that of nutrition; and, furthermore, ever changing by the non-abstraction or retention of morbid matter, *mal*-excretion, through the kidneys, skin, liver, and other excreting or secreting organs.

Urine for Examination.—The diagnostic interpretation of any particular state of urine obviously has reference to its source or origin in the system. The *products* arising and accruing from mal-assimilation —whether by that of digestion (primarily) or of nutrition (secondarily)—and which appear in the urine, can be selected for examination by observing a very simple precaution with regard to the sample of urine.

Urine secreted at from three to six hours after a meal presents the products of digestion; while that secreted several hours subsequently, when the urine from this source has run off, presents the products of nutrition in its destructive metamorphosis, or the *débris* of the textures. The latter may be called *urine of the blood;* and if examined in the morning before breakfast, after an interval of fasting from overnight, will be found to contain, unlike the *urine of digestion*, the waste of the textures. To make this observation complete, the bladder should be emptied overnight, to preclude any admixture of the urine then in the bladder with that which is secreted during the night. By this precaution, the products from these two sources of urine can be detected and distinguished, in most cases, with approximate certainty.

Changes in Urine from Decomposition, after Emission.—Stale Urine. —The changes which take place in the urine after emission, and as the result of decomposition, must not be mistaken for those which represent morbid conditions.

Healthy urine may thus undergo departures from its ordinary slightly acid reaction, in two opposite directions; becoming *highly acid*, or turning to an *alkaline* condition.

(*a.*) *Hyper-acidity, or Acid Urinary Fermentation* (Scherer).—This change consists in the generation of lactic acid and acetic acid; the mucus of the bladder acting apparently as a ferment on the urinary pigment. Like other fermentive processes, therefore, this one is prevented or arrested by alcohol or boiling, or by removing the ferment—vesical mucus—by filtration. The changes consequent on this production of acidity are a precipitation of the amorphous urates, then of uric acid, and often of oxalate of lime. Simultaneously, confervoid vegetations— the mould or sugar fungus—are apt to appear. Acidity, increasing for some five or ten days, declines as putrefaction succeeds. An ammoniacal reaction and odour now supervene, with opacity of the urine from the development of myriads of minute linear particles—vibrios. The amorphous urate deposit has become changed into dark round masses of urate of ammonia, uric acid crystals are replaced by bright prisms of triple phosphate, and amorphous phosphate of lime sinks as an abundant sediment. The growth of confervoid vegetations is arrested with the change of reaction, and they perish as putrefaction is established. Exceptions to this order of change occur. Urines of low acidity or of low specific gravity do not undergo any marked increase of acidity; but they become ammoniacal in a day or two, or possibly in a few hours.

(*b.*) *Alkalescence,* in exposed urine, results from the transformation of urea into carbonate of ammonia, and this change may be induced by contact with any decomposing matter, stale urine in particular.

(*c.*) Certain *organic deposits*, as blood-corpuscles, renal epithelium, and uriniferous tubule casts, are soon destroyed by an exposure of twelve or twenty-four hours, especially in urine of low specific gravity. But pus-corpuscles, scaly epithelium, and spermatozoa retain their microscopical characters for a much longer period, even to an advanced state of urinary putrefaction.

Bearing in mind all these peculiarities of decomposed urine, the rule should be to examine any specimen of urine within a few hours after its emission.

Clinical Examination of the Urine.—From a practical point of view, an examination of the urine is a much more simple procedure than that whereby original investigations are conducted, as commonly detailed in works on Urinary Pathology, and which necessarily involve a minute knowledge of chemical analysis and of microscopic manipulation beyond the requirements of clinical practice, or the time at command of those who are so engaged.

The following *method of examination* represents the order of procedure which will commonly be found sufficient, and the essential particulars to be noted with reference to morbid conditions of the urine, in ordinary cases.

(1.) *Physical Characters.*—Observe the colour, clearness or turbidity, any deposit or foreign body, odour, and specific gravity,—as shown by the urinometer. Reaction—acid, alkaline, or neutral, as tested by a slip of litmus paper, or yellow turmeric paper; the one becoming red, when the urine is acid; the other brown, when the urine is alkaline.

A deposit—observe its colour, admixture with, or separation from, the urine, and whether floating on the surface as a pellicle, suspended as a cloud, or precipitated as a sediment, apparently amorphous or crystalline.

(2.) *Chemical Tests.*—(*a.*) For Deposits. Effect of *heat.*—Pour a sample of the urine, with deposit, if present, into a test tube, and over the flame of a spirit-lamp heat gradually to ebullition. Observe the disappearance of turbidity, as when a deposit of *lithates;* or the appearance of turbidity, as by a deposition of *phosphates.* Or the latter appearance may be the coagulation of *albumen.* Drop a few drops of *strong nitric acid* into the tube, and heat again; the one deposit, phosphates, entirely disappears; the other, albumen, becomes increased and consolidated.

Other tests for deposits: solubility in acetic acid, in liquor potassæ; insolubility in both acids and alkalies.

An approximate estimate of the whole quantity of lithic acid, or of phosphoric acid, excreted, beyond what is indicated by any deposit, should then be determined.

(*b.*) For Foreign Constituents.—Albumen—note its absence or presence; and make an approximate calculation, from the quantity in a given measure of urine, of the whole quantity passed in twenty-four hours.

Sugar—note its absence or presence; and similar approximate calculation of quantity.

Bile, its absence or presence.

(3.) *Microscopic Examination.*—Crystals—note the absence or presence in urine, or in any deposit; their shape, or other characters. Note blood-corpuscles, pus and mucus corpuscles, epithelial cells, uriniferous tubule casts, spermatozoa. Vegetable parasitic productions, or as engendered in decomposing or fermenting urine, *e.g. Penicillium glaucum* in non-saccharine; *Torula cerevisia*, yeast-plant, in saccharine urine, when subjected to the fermentation test. Other foreign substances, *e.g.* hairs, cotton fibres from the towel used in examination, sputa, starch granules from admixture of food or tooth-powder, fæcal matter, particles of soot, sand, or dirt.

Appliances for Examination of Urine.—(1.) *Chemical.*—Certain simple chemical apparatus and tests will suffice for a clinical examination of the urine, and of its deposits.

The *apparatus* comprises—Urine glasses, rather tall and deep receptacles suitable for immersion of the urinometer in taking the specific gravity of urine, and a glass graduated as a measure; test-tubes, in a half-dozen series, with stand, spirit-lamp, and well-corked bottle of methylated spirit, slips or slides of glass, drop-tubes, and glass stirring-rods.

The *Tests* ordinarily required are—Acids: nitric acid fort., acetic acid. Alkalies: liquor potassæ, liquor ammoniæ fort. *Special* tests: sulphate of copper solution, or blue hydrated oxide of copper, or yeast for sugar-testing; sulphuric acid for bile-testing.

(2.) *Clinical Microscope.*—Oberhauser's microscope is an instrument which I have been accustomed to use for many years in the examination of the urine and its deposits. I have had the same instrument in work since the year 1853, a period of twenty-five years. The only inconveniences I have experienced in working it are that in altering the focus or the field of vision, respectively, the requisite adjustment cannot be so readily commanded by the hand movement of the tube, or the object, as it is by the screw movements in other microscopes. But, unprovided with this additional mechanism for either such purpose, the price of the instrument is much less, an important consideration with regard to its general eligibility.

Beale's clinical pocket microscope is a very simple, portable, and inexpensive instrument.

Object-glasses required for Clinical Examination.—Whatever form of microscope be preferred, the object-glasses, for magnifying the object to be examined, are the most essential requisite. The qualities of an object-glass consist in its magnifying power and achromatic character, by clearly defining the object, without any encircling play of colours. The powers most commonly useful in medical practice are two: the *quarter of an inch* focus, magnifying about 200 diameters, and the *inch*, magnifying about 30 to 50 diameters.

Microscope Lamp.—For examining objects by artificial light at night, or otherwise in the absence of daylight, some kind of illuminating contrivance will be necessary. An ordinary French lamp, provided with a blue glass chimney, may be used, or that recommended by Dr. Lionel Beale, a small paraffin lamp, with a round wick, may be preferred. But in the absence of any such lamp, a short wax candle, giving a clear white light, steadied by a screen, supplies a ready contrivance which will generally suffice.

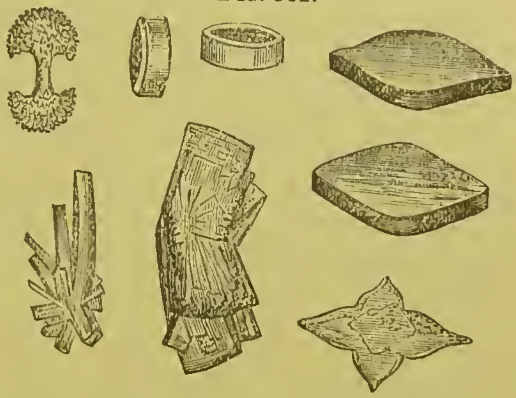
LITHIC OR URIC ACID ($C_{10}H_4N_4O_6$) IN URINE.—*Physical Characters of Urine.*—Clear, bright, golden or coppery colour, like brown sherry. Specific gravity increased. Quantity somewhat diminished. Acid reaction more decided, producing a deeper shade of red in blue litmus paper. A deposit of *yellow* or *red sand*, resembling particles of cayenne pepper,—lithic acid, sometimes in great abundance.

Diagnostic Value.—Lithic acid is eliminated from the blood, in combination with some base—soda, or ammonia more commonly, forming lithates of soda and ammonia. These salts, readily soluble in urine of the temperature of the body, are precipitated only when present in excess proportionately to the aqueous portion of urine secreted, and as the supersaturated solution cools. They then appear as yellowish or red brick-dust deposits, which will be presently described. Lithic acid may, however, be liberated from these salts, by decomposition; but it occurs only when *some other* acid is present in *excess* to replace the acid in combination. Free lithic acid, being insoluble, is then precipitated, appearing as a deposit in the urine having the above characters.

Microscopical Characters.—This deposit consists of minute crystals, in various shapes, of which rhomboidal prisms are the most commonly characteristic. (Fig. 861.)

Respecting the kind of acid by which uric acid is thus deposited, Dr. Parkes observes:[*] "It does not follow that the acidity should be owing to any single acid; it is owing either to an augmentation of all the usual acids of the urine — the sulphuric, phosphoric, and perhaps the hippuric, the lactic, and the carbonic—so that the bases are insufficient to neutralize them, or the formation of acids after emission of the urine, viz., probably the lactic, acetic, butyric, or oxalic.

FIG. 861.



"It is, of course, possible that the deposit of uric acid may be owing, not to excess of other acids, but to absolute deficency of alkali. No facts have yet been discovered on this point.

"The two causes of increased acidity of the urine—excess of normal acids, and formation of acid after emission—are sometimes in simultaneous action. The urine depositing lithic acid without lithates is not usually the high-coloured, red, pigment-loaded urine, but yellow and transparent; the acid is deposited slowly, and without admixture with lithates. Uroxanthin (indican) is often present in large quantity; and, as Virchow suggests, it may more rapidly form acid than common pigment."

The practical issue of all these considerations is this—that to rightly estimate the value of "lithic acid urine," as the sign of a corresponding "morbid blood-condition," it is necessary to discover the *total* amount of lithic acid excreted from time to time; and for this purpose we cannot trust any *deposit* thereof, either combined or free. The lithates may be in excess, *short* of a supersaturated solution; and lithic acid itself becomes apparent only when the urine is hyper-acid from *other* causes.

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[*] "Composition of the Urine, in Health and Disease, and under the Action of Remedies," p. 218.

Chemical Tests.—The over-acid reaction, as shown by blue litmus paper, has already been noticed.

A *deposit* of uric acid is insoluble in hot water, but soluble in alkalies—potash, soda, and ammonia.

A portion of the deposit is to be dissolved in a drop of potash. The alkaline solution is then to be treated with excess of acetic acid. In a few hours, crystals of uric acid will have formed, which can be identified by microscopic examination.

A portion of the deposit may be placed on a glass slide, and treated with a drop of strong nitric acid. Evaporate to dryness by a gentle heat, and expose the slide to the vapour of ammonia, or add a drop. A beautiful violet colour, from the formation of murexide, attests the presence of uric acid, or a urate (L. Beale).

The *total amount* of lithic acid excreted can be discovered by a simple experiment, devised by Dr. Golding Bird. Let all the urine passed in twenty-four hours be collected, well shaken, and a given quantity—say about two ounces—be mixed in a conical glass vessel, with about half a drachm of hydrochloric acid. In six or eight hours crystals of uric acid are copiously deposited on the sides of the glass. To insure their complete separation, they should be allowed to repose for twenty-four hours, and may then be washed, dried, and weighed.* Simple multiplication shows the whole amount of uric acid secreted in the twenty-four hours, without the chance of any considerable error. In estimating the pathological importance of the result thus obtained, the healthy standard of quantity should be remembered, and this ranges from six to ten grains of uric acid in twenty-four hours.

URATES OR LITHATES OF SODA OR AMMONIA IN URINE.—*Physical Characters of Urine.*—Turbid in all cases on cooling and depositing lithates; the other characters are in accordance, principally, with their colour. *White* lithates are deposited from a pale-coloured urine; specific gravity low—1·010 to 1·014. The deposit is suspended, having a whitish, flocculent, cloudy appearance, which resembles mucus. *Fawn*-coloured lithates are deposited from an amber-coloured urine; specific gravity higher, but still lower than normal, being about 1·018. *Red* brick-dust lithates are deposited from a yet deeper-coloured urine, and of higher specific gravity. *Purple* and *pink* lithates are deposited from a corresponding coloured urine, and of high specific gravity. The quantity of lithates secreted, and precipitated spontaneously, may not be equal. Hence the latter may not indicate the *whole* quantity. They are held in solution by urine of the ordinary temperature of the body, 98°; but as the urine cools on exposure in the vessel used for its reception, the lithates are deposited. The proportion of water, as a constituent of urine, will also regulate the quantity deposited. These two conditions have been already noticed. But over-acidity of urine, owing to other acids in excess, allows an abundant deposit; whereas, a slightly acid or alkaline urine holds a proportion of the lithates in solution.

Microscopical Characters.—Amorphous granules is the usual appearance of lithate of ammonia, as seen under the microscope (Fig. 862); but certain forms of crystal are, occasionally presented. Thus, spherules sometimes constricted in the middle, assuming a dumb-bell shape, or spherules with little claw-like projections. (See Fig. 862.) The junction of lithic acid crystals gives rise to various singular appearances.

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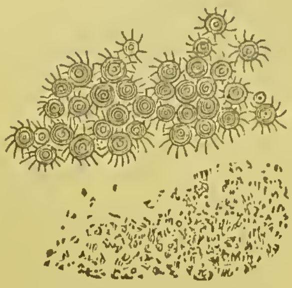
* "Urinary Deposits," 4th edit. See also Animal Chemistry," etc., by Bence Jones, M.D., p. 53.

FIG. 862.



Chemical Tests.—Heat redissolves the lithates. Hot, not to say boiling, water poured into the chamber-utensil, causes the turbidity to disappear, and thus clears the urine. But this result may be partly due to the increased proportion of solvent—water—thus added to a previously concentrated urine. A small quantity of the turbid urine heated in a test-tube becomes clear, but it again becomes turbid on cooling. The deeper-coloured urates are dissolved by a rather higher temperature than the paler varieties. Alkalies—potash or ammonia—dissolve these deposits; acids—hydrochloric or acetic—separate uric acid, having the appearance and crystalline forms already described.

A rough approximate analysis of the urates may be readily accomplished. The uric acid having been determined in a weighed portion of the dried urate by dilute hydrochloric acid, another portion of the urate should be burnt, and, after washing the ash, tested with the blowpipe. If the base be ammonia, a very small quantity of ash only will remain. For a full analysis of the urates, they should be previously examined with the microscope to ascertain whether they are free from phosphate of lime or magnesia, or oxalate of lime (Hassall).

Potash may be the most abundant base, next ammonia, and last soda (Bence Jones). *Lime* is always present in considerable quantity (Hassall and Scherer). *Magnesia* is an occasional base (Robin and Verdeil).

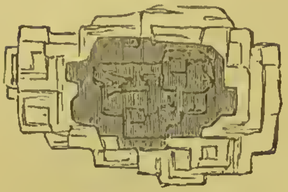
It would, therefore, appear that the term *mixed* urates more accurately designates this deposit. The proportion of uric acid is always large—over eighty per cent. (Scherer); over ninety per cent. (Bence Jones).

UREA ($C_2H_4N_2O_2$) IN URINE.—*Physical Characters of Urine.*—Excess of urea may occur, without diuresis,—the quantity of urine seldom exceeding the normal quantity, but the quantity of urea being both absolutely and relatively greater than in health; or with diuresis,—the quantity of urine being excessive, and the quantity of urea, therefore, in a given specimen, less than in health, but the quantity, absolutely and relatively to the other constituents, greater also, in this case, than normal. *Azoturia*, or ureal diabetes, as the latter may be termed, although differing only in degree, is a very rare disease.

The former condition of urine is, in colour, clear and pale, but occasionally assuming the appearance of porter diluted with water; odour not peculiar, but ammoniacal (apparently from decomposition of the urea) when not quite fresh; specific gravity rather above the average, 1·020, but varying from 1·015 to 1·030, or even higher. Quantity about normal. Reaction acid when the urine is fresh, but speedily becomes alkaline, from ammonia. A deposit of urea, in crystals, soon forms by evaporation, on the addition of nitric acid, forming the nitrate of urea.

Microscopical Characters.—Long needle-shaped crystals, by evaporating a drop or two of urine on a slip of glass. Nitrate and oxalate of urea also present crystals; the former in hexagonal plates and rhombic octohedræ (Fig. 863); the latter in rectangular and right rhombic prisms, with a tendency to the formation of dumb-bell shaped oxalate of urea.

FIG. 863.



Chemical Tests.—Nitric acid added to a few drops of urine on a slip of glass, forms the nitrate of urea ($C_2H_4N_2O_2,HO,NO_5$), which, on evaporation, appears as a crust, more or less thick, according to the *quantity* of urea. Oxalate of urea ($C_2H_4N_2O_2,HO,C_2O_3$) is formed in like manner. Either compound can be verified by microscopical examination, while the chemical test indicates, approximately, the *quantity* of urea present.

Other tests are described in special works, but the above is the most ready method of detecting and determining urea.

The separation of urea, in a free state, may be obtained from either the nitrate or oxalate, by the following simple process:—Dissolve the oxalate of urea, for example, in hot water, and treat the solution with carbonate of lime, until effervescence ceases; the oxalate of lime thus formed, and any excess of the carbonate, are precipitated, leaving the urea in solution. Carbonate of baryta may be used instead of the lime salt. Nitrate of urea may be decomposed in like manner. Crystals of nitrate of baryta are thrown down; the fluid is to be filtered, evaporated, and the residue extracted with ether.

Distinctive Characters of Urate of Soda, Earthy Phosphate, and Pus.—These three deposits are very similar in appearance, but have widely different pathological significance. Their certain and easy distinction is therefore of great practical importance. The following simple method of examination, and distinctive characters, are given by Dr. Lionel Beale.

Let the urine stand in a conical glass for some time. Then pour off the clear supernatant fluid, and transfer a small portion of the deposit into a test-tube. Add about half the bulk of solution of potash, and observe:—

1. If urate of soda and ammonia, the potash may cause the mixture to become *clear*, but not viscid.
2. If entirely phosphate, *no change* will be produced.
3. If pus deposit, the mixture will become *clear*, and very *stringy* or viscid.
4. If both pus and phosphate be present, the mixture gelatinizes, but does not become clear.

Microscopic examination will confirm this chemical test.

PHOSPHATES IN URINE.—Amorphous phosphate of lime—bone-earth ($3CaO,PO_5$). Crystallized phosphate of lime ($2CaO,HO,PO_5+3HO$). Phosphate of ammonia and magnesia—triple phosphate ($NH_4O,2MgO,PO_5+12HO$). Phosphate of soda ($2NaO,HO,PO_5+24HO$). Acid phosphate of soda ($NaO,2HO,PO_5+2HO$).—*Physical Characters of Urine.*—Turbid in all cases, on depositing phosphates; of a pale yellow colour, if the deposition be occasioned by fixed alkali—potash or soda, and of an orange-brown colour, if occasioned by carbonate of ammonia—volatile alkali; the odour is ammoniacal in the latter case, while the specific gravity varies greatly with the colour—the pale urine having a low specific gravity, the higher-coloured a high specific gravity. The quantity is increased generally. The reaction varies—being alkaline or neutral, or slightly acid when first evacuated. The deposit of phosphates appears as a *white sand*, but generally combined with mucus, often present in large quantity, and pus, probably, in variable quantity.

Diagnostic Value.—Phosphatic urine, as ordinarily estimated by the amount of phosphates *deposited* in the urine, is deceptive. Phosphatic urine, in this sense, is only an appearance, not a true measure of the whole amount of phosphates present, and of the pre-existing blood-condition.

The pathological significance of phosphatic deposits in the urine has been investigated more particularly by Dr. Bence Jones.

Of *all* the phosphates *present*, not necessarily deposited, in the urine, those of soda are most abundant; equalling in amount three or four parts of the whole. The earthy phosphates of lime and magnesia represent the remainder. Phosphatic urine, therefore, should rather, of the two, have reference to the former salts. But the phosphates of soda are so very soluble in water and in acid or alkaline urine, that they are never deposited. In this respect resembling the sulphates of potash or soda, any excess of these phosphates remains concealed. On the contrary, the phosphates of lime and magnesia are scarcely soluble in water, and nearly insoluble in alkalies, although very soluble in acids, even in acid phosphate of soda. Therefore, whenever the urine becomes alkaline, down go the phosphates of lime and magnesia. This precipitate, however, denotes only the quantity of lime and magnesia drawn from the blood, and now appearing in the urine. The *major* portion of *phosphoric acid*, being combined with soda, remains unobserved.

By taking more lime or magnesia in the food, or by adding these bases to the urine, we increase the amount of earthy phosphates; and by a sufficiency, we precipitate *all* the phosphoric acid in combination with *them*, thus leaving no *phosphate* of soda in solution. Conversely, if we could abstract all the lime and magnesia, no precipitate would appear by adding alkalies—in which, as well as acids, phosphate of soda is soluble—though there remained a great excess of phosphate of soda concealed in solution. But if lime and magnesia are present, as usual, in the urine, a portion of the phosphoric acid appears in combination with them, forming a deposit of *these* phosphatic salts whenever the urine becomes *alkaline*, in which they are insoluble. Hence the more appropriate name, *alkaline* urine, suggested by Dr. Bence Jones, rather than phosphatic urine, as ordinarily understood, which represents merely the amount of lime and magnesia present in combination with phosphoric acid. If regarded from this latter point of view, the term "phosphoric diathesis" should be extended to denote an increase in the *total* amount of phosphates, *alkaline* and earthy; or, if limited to one phosphate, it ought to denote *alkaline* phosphate, that being proportionately four or five times more abundant than earthy phosphates in the urine. Moreover, the term "earthy diathesis," as indicated by the urine, if used at all, ought to signify urine which really contains an *excess* of lime and magnesia, and not the precipitation, it may be of only a small quantity, of those earthy salts, the urine having lost its healthy property of retaining them in solution on becoming alkaline.

In short, alkalescence of the urine and increase in the *total* amount of phosphates have no relation of any kind to each other. They are quite distinct, and, indeed, rather opposite states.

Microscopical Characters.—Supposing *alkalinity* of the urine be due to *fixed* alkali—as potash or soda—the phosphate of lime and the phosphate of magnesia are immediately deposited, appearing as a "white sand." Submitted to microscopic examination, these salts are seen to consist of amorphous particles, or small round globules, and, occasionally only, prismatic crystals with oblique or dihedral summits. According to Hassall's observations,* crystallized phosphate of lime is common, much more so indeed than amorphous phosphate, which he regards as unusual.

This white deposit and coexisting alkaline condition of the urine occur whenever an excess of fixed alkali, or, what is equivalent, a deficient proportion of acid, is taken in the food. The urine is *secreted* alkaline, and deposits its earthy phosphates in greater or less abundance, according to the quantity of lime and magnesia present.

Not to be misled by an alkaline condition of the urine from *fixed* alkali, it is most important to know and remember that the acidity of *healthy* urine varies considerably during the diurnal period. According to the observations of Dr. Bence Jones, confirmed by those of Dr. W. Roberts, it is *inversely* to the acidity of the stomach. During digestion, when some acid—probably the hydrochloric—is being secreted by the stomach, an equivalent amount of soda or potash, previously in combination, must remain as free alkali in the blood, rendering it proportionately more and more alkaline. Accordingly, the urine becomes less and less acid, and perhaps eventually decidedly alkaline. When acid ceases to flow into the stomach, and any superfluous portion which had been secreted is re-absorbed, the blood regains its former *average* degree of alkalescence; the urine also is secreted less and less alkalescent, and becoming acid, its acidity rises until the next meal, when the highest degree of acidity is attained. If no food be taken, this condition of urine remains stationary for about twelve hours; immediately after a meal, its acidity again falls, and gradually approaches an alkaline reaction.† Examined at such time, alkalinity of urine might inadvertently be regarded as a morbid condition; but examination of another and another sample excreted some time after a meal, when the process of digestion is completed, corrects this suspicion; the urine thenceforth is found more and more acid prior to the next meal, when the alkaline retrogression supervenes.

This alternation of an alkalescent state of the urine during digestion, and restoration of acidity on completion of digestion, invalidates the result of *any one* examination of the urine. A *mixed* sample of the whole amount of urine excreted during the twenty-four hours will give its average condition.

If *volatile* alkali—as carbonate of ammonia—be the occasion of alkaline urine, then the *deposit* consists of the ammoniaco-magnesian phosphate, together with some phosphate of lime; the former appearing in the form of transparent prismatic crystals, or of foliaceous, stellar, or penniform crystals. (Fig. 864.) The two latter are phosphate of lime.*

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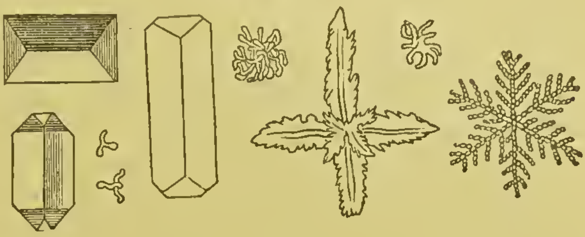
* *Lancet*, p. 850, vol. i.; and "Med.-Chir. Trans.," vol. xxxvi.

† See adverse observations by Dr. Julius Vogel; "A Guide to the Analysis of the Urine," by C. Neubauer and J. Vogel. 4th ed. Translated for New Syd. Soc. by W. A. Markham, 1863, p. 296.

This deposit occurs whenever phosphates are deposited in connection with an inflamed state of the mucous membrane of the bladder, the ammonia being supplied by the decomposition of urea, which constituent of the urine may be regarded as carbonate of ammonia, plus two atoms of water. Whether urine is ever *secreted* ammoniacal appears doubtful; without doubt, however, it may become so, after emission, by decomposition of the urea. This source of the ammonia present in the phosphate, as then formed, was first clearly perceived by Lecanu, and has since been explicitly pointed out by Dr. Owen Rees. The decomposition of urea is effected apparently by the mucus acting as a ferment, which is always more freely secreted by an inflamed mucous membrane, as in pyelitis and cystitis. Ammoniaco-magnesian phosphate, consisting of its characteristic crystals, is abundantly deposited; and equally so, a white tenacious substance, that can be drawn into skeins of considerable length. It is said to consist of pus-globules, they having become adherent under the action of ammoniacal urine. Thence the phosphate above mentioned, together with granules of phosphate of lime, are involved in one gelatinous mass. This mixed deposit is frequently witnessed in cases of paralysis affecting the bladder, which then assumes a condition bordering on inflammation.

FIG. 864.



Chemical Tests.—All the phosphates are dissolved by acids—unlike coagulated albumen; and remain unaffected by heat—unlike the lithates; but the following points of contrast distinguish the two kinds of alkaline urine—the ammoniacal from that caused by fixed alkali.

Ammoniacal urine effects no change in blue litmus paper until it dries, when the pink colour immediately appears.† Urine becoming alkaline during digestion, *i.e.* from *fixed* alkali, turns pink paper blue, which remains so when dry. *Ammoniacal* urine deposits crystals of phosphate of ammonia and magnesia; while urine otherwise alkaline, from *fixed* alkali, deposits an amorphous powder of phosphate of lime. The former deposit is associated with mucus and pus; the latter with mucus only, and rarely in great quantity. *Ammoniacal* urine is constantly alkaline; that from fixed alkali is only occasionally alkaline, *i.e.* at particular periods of the day. *Ammoniacal* urine is a sign of local disease—inflammation of the urinary mucous membrane; whereas alkalescence from *fixed* alkali is a sign of a more general disorder, *i.e.* indigestion.

Guided by these characters, we can detect and discriminate the *kind* of alkali present in the urine, and its *source.* Yet such diagnosis, founded on the kind, and even the amount, of phosphatic salts *deposited* by the urine, signifies nothing concerning the *total* amount of phosphates *excreted from the blood.* The non-appearance of phosphates does not imply their absence, and their appearance is no measure of the total amount present. The question therefore, an all-important one, presses, whether an *excess* of phosphates is accumulating in the blood, consequent on some perversion of nutrition or digestion, and constituting the true "phosphoric diathesis"? Mere inspection of the urine may disclose nothing respecting this constitutional morbid condition; and should the urine be alkaline, we then discover merely the amount of earthy bases—lime and magnesia excreted in combination with phosphoric acid, and deposited. But this deposit of phosphoric salts contains only part of the whole phosphoric acid present. By far the greater portion remains concealed in the soluble phosphate of soda, which is never spontaneously precipitated under any circumstances.

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* *Lancet*, 1853. (Hassall.)

† See "Trans. of the Chemical Society," vol. ii. p. 244, communication by Dr. Bence Jones.

To determine the *whole amount* of phosphoric acid eliminated, it is necessary to ascertain the amount of this alkaline phosphate, as well as that of the earthy phosphates. Both together represent the phosphoric diathesis.

For this purpose the following experimental process is recommended by Dr. Bence Jones:—About a thousand grains of urine are to be weighed, and the earthy phosphates precipitated by pure ammonia, free from carbonate. These should be filtered, washed with ammoniacal water, and heated to redness; adding at last a drop or two of nitric acid. The amount of earthy phosphates is determined by weighing the residue. The alkaline phosphates are estimated by taking about five hundred grains of urine, adding an excess of chloride of calcium, and then pure ammonia. Thus all the phosphoric acid is precipitated as phosphate of lime. This is to be filtered, well washed, and the filter and the precipitate burnt with a drop or two of nitric acid. If the filtration has been slow, it is necessary to redissolve the residue in a platinum crucible by hydrochloric acid, and to reprecipitate by pure ammonia, when the filtration will take place very rapidly. After being burnt, the crucible is weighed, and by deducting the previously determined earthy phosphates, the difference may be taken as the amount of alkaline phosphate.*

OXALATE OF LIME ($C_2O_3 + CaO + 2HO$) IN URINE.—*Physical Characters of Urine.*—Clouded with much epithelium, and of a bright amber colour, somewhat resembling the bright golden-sherry colour of lithic acid urine, but contrasting with the pale, whey-like urine of earthy phosphates, and the turbid orange-brown of ammoniacal urine, which, moreover, presents an iridescent pellicle on its surface, and is ropy and fetid. The specific gravity varies extremely, from 1·015, or less, to 1·025, or more. Quantity of urine not much increased. Reaction decidedly acid. No deposit of oxalate, unless present in some quantity, and after some hours or days, then appearing as minute, colourless, transparent, hemp-seed concretions, mingled with mucus as a cloudy deposit.

On being heated, the urine may become gelatinous, yet retain its transparency.

Microscopical Characters.—Crystals in three forms: octohedra, the most common, or as dumb-bell shaped crystals; occasionally in the shape of small, red blood-globules, probably the earliest stage of dumb-bell oxalate. All these are here represented. (Fig. 865.)

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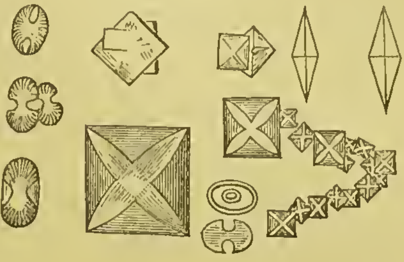
* See "Phil. Trans.," 1845, p. 365.

FIG. 865.



Chemical Tests.—To determine the *whole* quantity of oxalic acid—free, or in combination with alkalies and soluble, or with lime, a portion of which oxalate may be precipitated—the urine of twenty-four hours must be collected. This should be evaporated to about one-fourth its bulk, neutralized with ammonia, be strongly acidulated with acetic acid to keep the phosphates dissolved, and then a solution of chloride of calcium added. The oxalate of lime thus formed is to be separated by filtration, dried, converted into either the carbonate or the sulphate in the usual manner, weighed, and the oxalic acid calculated from the resulting carbonate of sulphate. If there be any reason to suppose that the oxalate is mixed with uric acid, then dissolve in hydrochloric acid, filter, neutralize with ammonia, and again acidulate with acetic acid (Hassall).

Should any oxalate of lime have become deposited before examination, this may be either separated or redissolved.

To estimate the *diagnostic* importance of oxalate of lime in the urine, it should be remembered that this state is of very frequent occurrence, and its presence cannot be regarded as signifying a morbid blood-condition, excepting in respect of the *quantity* secreted. A few minute crystals are quite compatible with health; but large crystals in large quantity and *persisting* for a considerable period indicate such morbid condition.

The following observations by Dr. Golding Bird, respecting the composition of oxalic acid urine, relate to the circumstances under which it occurs.

In rather more than one-third of the cases examined, uric acid or urates existed in large excess, forming the greater bulk of the resulting deposit. In all there existed a greater proportion of urea than in healthy urine of the same density; and in nearly thirty per cent. of the cases, so large a quantity of urea was present, that the fluid crystallized into a solid mass by adding nitric acid. The urate of ammonia found in the deposits of oxalic acid urine is occasionally tinted with a pink hue. An excess of phosphate frequently accompanies the oxalate. The presence of sugar in the specimens examined was exceptional.

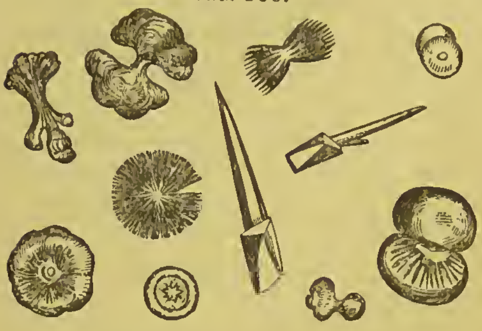
Prout regarded the oxalic acid diathesis as a substitute for that of lithic acid, the former being preceded and followed by the latter. Liebig demonstrated the intimate relation of lithic acid to urea and oxalate of lime, the two latter having been formed artificially from the former; and this conversion of lithic acid was shown by Wöhler's experiments to take place in the bodies of animals.

Oxalic acid urine—properly so called from the quantity of this acid excreted—is therefore an expression of *many* morbid conditions. Taking patients indiscriminately in a Hospital, Dr. Bence Jones concludes that oxalate of lime is notably present in the urine in nearly one out of three. Diseases of many kinds, and of opposite characters, are apparently conducive to this result: indigestion, especially if attended with flatulence, and in cases also where no indigestion was ever experienced; skin diseases, and in cases where the skin was never affected; in acute rheumatism, acute gout, fever, and in diseases of women and children.

SULPHURIC ACID (HO,SO_3) IN URINE.—*The Physical Characters of the Urine* are not, apparently, peculiar, and therefore not distinctive. They would appear to resemble generally those of febrile urine. No deposit of sulphates ever occurs, they being soluble in urine—acid or alkaline—including ammoniacal urine.

Microscopical Characters.—Crystals of sulphates may be readily procured by evaporating a small quantity of urine on a slip of glass. The sulphate of *potash* then appears in the shape of short six-sided prisms, terminated by six-sided pyramids; but frequently the body of the crystal is wanting, thus presenting a triangular-faced dodecahedron. Also in the shape of rosettes and dumb-bells. (Fig. 866). Sulphate of *soda* appears as decahedral crystals.

FIG. 866.



Chemical Tests.—By adding a soluble salt of baryta, *e.g.* chloride of barium, the sulphate of baryta formed is insoluble and conspicuous, thus representing the sulphuric acid present; but not discovered by merely inspecting the urine, in which the sulphates of potash and soda are absolutely soluble, whether the urine be itself acid or alkaline. The readiness with which the insoluble baryta sulphate appears will show the excess of sulphuric acid.

The *whole* quantity of sulphuric acid present may be determined as proposed by Dr. Bence Jones: about five hundred grains of urine are weighed, and chloride of barium is then added in excess, a few drops of hydrochloric or nitric acid being used to insure the solution of the phosphate of baryta. Heat is applied, and the liquid boiled for a few minutes briskly. The sulphate of baryta is filtered and washed until the clear liquid is perfectly free from chloride of barium. The filter is burnt, and the residue weighed. The amount of sulphate of baryta in a known quantity of urine is thus determined, and the whole amount in twenty-four hours can be calculated.

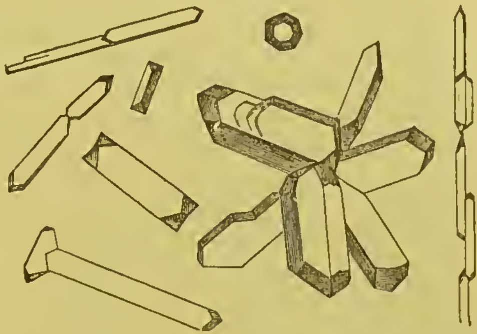
Diagnostic Value.—The interpretation of sulphuric acid in the urine is somewhat parallel to that of phosphoric acid. The quantity of either acid present, absolutely and relatively to the other urinary constituents, is the question with reference to the blood-condition. Unlike phosphoric acid, *no part* of the sulphuric acid is ever deposited in combination, *i.e.* as sulphates of potash and soda; they being the only sulphates—excepting, perhaps, a little lime sulphate—completely soluble in any urine, even alkaline urine. But the greater part—about three-fourths of the whole of the phosphoric acid—is in combination with these alkaline bases, and these phosphates are completely soluble in any urine, and never deposited. While, therefore, mere inspection of the urine overlooks the greater portion of the phosphoric acid present, it discovers none of the sulphuric acid. On the other hand, the remaining small portion of phosphoric acid in combination with the earthy bases, lime and magnesia, being insoluble only in alkaline urine, their precipitation indicates and measures only the alkalescence of the urine,—by fixed alkali, potash or soda, or the volatile alkali ammonia. Not even this chemical condition of the urine is discoverable through the sulphates, which never appear.

Chemical examination of the urine—as already described—by the formation of the sulphate of baryta, which is insoluble, and deposited accordingly, will discover the presence of sulphuric acid, and its whole amount.

HIPPURIC ACID ($HO,C_{18}HNO_5$) IN URINE.—*Physical Characters of Urine.*—The colour varies—pale, or, it may be, resembles that of febrile urine; the odour is generally like that of whey; specific gravity below rather than above the healthy average—1·020, and in one case (by Bouchardat) it varied from 1·006 to 1·008. Quantity copious. Reaction, generally, very faintly acid, neutral, or alkaline. A deposit of triple phosphate of magnesia not unfrequently occurs.

Microscopical Characters.—Crystals of the oblique rhomboidal prism, and its modifications, are obtained by evaporating two or three drops of fresh urine, to which a little hydrochloric acid has been added, on a slip of glass. (Fig. 867.) In stale urine, the hippuric will be found converted into benzoic acid; but its crystals, obtained in like manner, are characteristically different — thin glistening scales.

FIG. 867.



Chemical Tests.—Neutralize the acid with lime, concentrate by evaporation; add hydrochloric acid, in a flask, to decompose the hippurate of lime; introduce ether in large quantity, and cork the flask; agitate from time to time, pour off the ethereal solution which floats on the surface, wash it with water to remove traces of hydrochloric acid, and then evaporate to obtain the free hippuric acid.

If the ether should not separate readily from the mixture, add a very small quantity of alcohol; the water added removes the latter, and any urea in solution, as well as the hydrochloric acid.

LACTIC ACID ($HO,C_6H_5O_5$) IN URINE.—*Physical Characters of Urine.*—Not distinctive.

Microscopical Characters.—Crystals of the lactates of zinc, lime, and copper may be obtained, which are characteristic; the former especially, being thick rhombic tablets in clusters, and those of lime having the appearance of double brushes.

Chemical Tests.—Evaporate fresh urine to the thickness of syrup, by means of a low temperature with the water-bath, treat the residue with alcohol holding oxalic acid in solution, treat the alcoholic extract with an excess of hydrated oxide of lead, filter the solution, remove the excess of lead by sulphuretted hydrogen, boil the filtrate with oxide of zinc, filter again and evaporate to concentration, and lactate of zinc will appear with its characteristic crystals.

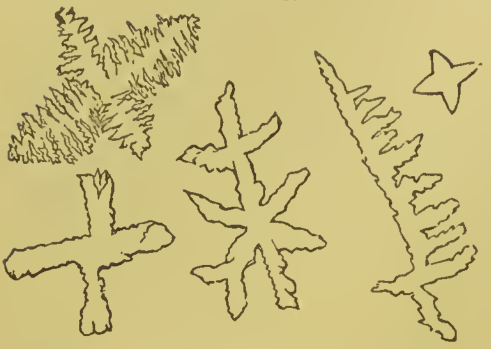
Lactate of lime may be formed by first procuring a solution of lactate of baryta, and then decomposing with sulphate of lime.

Or, the lactate of copper from that of lime, by adding sulphate of copper.

CHLORIDES IN URINE.—Chloride of sodium ($NaCl$). Chloride of potassium (KCl). Chloride of ammonium (NH_4Cl).—*Physical Characters of Urine.*—Not distinctive.

Microscopical Characters.—The chlorine is, for the most part, in combination with sodium, and the chloride of sodium readily crystallizes. By evaporating a drop or two of urine on a slip of glass, crystals are obtained in the octohedral form, distinguished from those of oxalate of lime by their principal axis being longer, and by not polarizing light. Half-octohedra, which are occasionally striated, is another form. Dodecahedra, or twelve-sided crystals, are the rarest form. By evaporation also, or from a solution of the ash of urine, the salt often crystallizes in the form of crosslets and daggers. (Fig. 868.)

FIG. 868.



Chemical Tests.—Nitrate of silver, in solution, is a handy test for the presence, or qualitative determination, of chloride of sodium in urine. One caution only is required: to strongly acidulate the urine with nitric acid, in order to prevent the precipitation of phosphate of silver; or the nitric acid may be added after the nitrate of silver, when any phosphate of silver will be immediately dissolved (Thudichum).

The quantity may be determined, either by weighing the white precipitate—chloride of silver; or volumetrically, by noting the quantity of a solution of nitrate of silver, of known and appropriate strength, required to separate the whole of the chlorine.

SUGAR ($C_{12}H_{12}O_{12}$) IN URINE.——Diabetes *mellitus* is the expression sometimes used for that disease whereof sugar in the urine is the sign; and this attributive title seems necessary to distinguish ordinary diabetes from a variety contra-designated Diabetes *insipidus.* In the former, farinaceous matters are probably converted into dextrin, and thence at once into grape-sugar; but there is some reason to believe that this succession of metamorphoses may be interrupted, and that an *insipid* sugar is then formed intermediately between dextrin and sugar of milk (Bence Jones). This tasteless sugar resembles sugar of milk, differing from it in not giving rise to mucic acid and in undergoing fermentation. It can be converted into grape-sugar by the action of acids.

Diabetes insipidus has received other names—Polydipsia (Becquerel), Diuresis and Hydruria (Willis). The secretion thus signified, of a large quantity of *watery* urine, is probably a distinct disease. Aqueous diabetes commonly occurs in connection with hysteria; and the term *hydruria* distinguishes it from *azoturia*, of which disease an excessive excretion of *urea* is the prevailing characteristic. The absolute amount of urea excreted in the twenty-four hours may be increased in hydruria; no sample, however, of such urine contains its normal proportion to the water secreted.

Physical Characters of Urine.—Clear, pale-straw, or greenish tint; sweet smell and taste; specific gravity high, averaging 1·040, and the quantity much increased, to 100 ounces, or even 400 ounces, in twenty-four hours. A crystalline deposit of sugar readily forms as an efflorescence on any clothing or other surface where the urine may happen to dry. The reaction is acid, but neutral or slightly alkaline if the quantity of sugar be small and the urine fresh.

Microscopical Characters.—Crystals in the shape of rhombic plates, six-sided, aggregated into roundish granules, or as single plates. (Fig. 869.)

Chemical Tests.—The composition of diabetic urine is peculiar in containing a *foreign* ingredient—glucose, or sugar of the grape, and excreted, possibly, in quantity varying from 1 lb. to 2 lbs. or more, in twenty-four hours; whereby a patient may pass more than his own weight of sugar in the course of a few months. The urine contains, also, usually rather more than less of its ordinary constituents.

Diagnostic Value.—Saccharine matter is occasionally present, and as a mere trace, in healthy urine; but any more obvious quantity, and *persisting*, is abnormal.

To estimate the pathological significance of diabetic urine, therefore, the constant presence of sugar in any notable quantity, rather than its absolute amount, is the diagnostic sign of consequence.

To detect this morbid condition in its infancy—indicating a corresponding blood-condition—certain tests, more delicate even than the production of the rhombic crystals, can be applied with signal success.

FIG. 869.

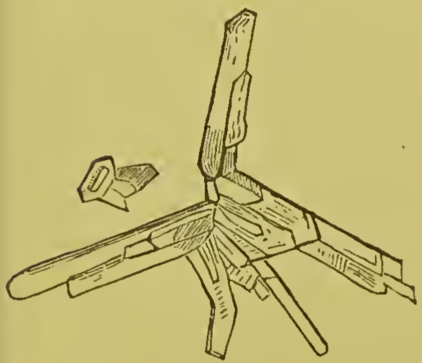
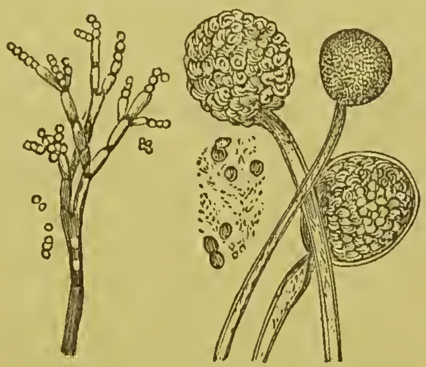


FIG. 870.



Yeast or *Fermentation Test.*—This is easily applied. Add a small quantity of yeast to some of the suspected urine in a saucer; invert a test-tube filled with this mixture, and stand it in the saucer; then place the whole in a warm room. If sugar be present, fermentation soon begins, and bubbles of carbonic acid rising in the tube accumulate and depress the fluid. Minute fungoid growths also are developed, which can be seen with the aid of the microscope. Another fungus—*Penicilium glaucum* (Fig. 870, to left)—the mildew that overspreads decaying vegetable or animal matter, and which may appear in *non*-saccharine urine, is apt to be mistaken for this "yeast-plant"—*Torula cerevisiæ.* (Fig. 870, to right.) Their distinctive microscopic characters were pointed out by Dr. Hassall.*

Certain *chemical* tests are more conclusive. They all depend on the facility with which the composition of diabetic sugar is changed; and this can be readily effected by salts of copper, and by alkalies.* Full directions for the successful application of these tests are given in Golding's Bird's work; † the following particulars, however, are essential to our purpose—the early and exact detection and discrimination of diabetic urine :—

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* "The Urine in Health and Disease," 1863, pp. 149–151.

Copper, or *Trommer's Test.*—Add to the suspected urine in a large test-tube just enough of a solution of sulphate of copper to communicate a faint blue tint. A slight deposit of phosphate of copper generally falls. Liquor potassæ must then be added in great excess; a precipitate of hydrated oxide of copper first falls, which redissolves in the excess of alkali, if sugar be present, forming a blue solution like ammoniuret of copper. On gently heating the mixture to ebullition, a deposit of red suboxide of copper falls, if sugar be present.

Cappezzuoli's Test.—Add a few grains of blue hydrated oxide of copper to urine in a conical glass vessel, and render the whole alkaline by adding liquor potassæ. If sugar be present, the fluid assumes a reddish colour, and in a few hours the edge of the oxide deposit acquires a yellow colour, which gradually extends through the mass, owing to the reduction of the oxide to a metallic state (suboxide ?).

Potash or *Moore's Test.*—Place in a test-tube about two drachms of the suspected urine, and add nearly half its bulk of liquor potassæ. Heat the whole over a spirit-lamp, and allow active ebullition to continue for a minute or two; the previously pale urine will become of an orange-brown or even a bistre tint, according to the proportion of sugar present. The subsequent addition of an acid generally causes the evolution of an odour of boiling molasses. Should the liquor potassæ contain lead, a dark colour is produced by the sulphur in the urinary excretion acting on it, which might lead one to suspect the presence of sugar when none exists—a source of error first pointed out by Dr. Owen Rees. Hence it is important to preserve the test-solution in bottles of green glass free from lead.

For Traces only of Sugar.—Certain tests are appropriate for the detection of sugar, when present in otherwise unappreciable small quantity—as a mere trace. The application of such tests implies the previous separation of some of the other constituents, which would interfere with their action.

(*a.*) *Brücke's Test.*—Add to the suspected urine neutral acetate of lead, and afterwards basic acetate of lead. Separate the precipitate by filtration, and add ammonia to the solution. The precipitate, by ammonia, is decomposed by oxalic acid, or suspended in water, and sulphuretted hydrogen passed through it. The filtered solution contains the sugar, which can then be detected by any of the tests already described.

This process will detect the seventh of a grain of sugar, diluted with more than six ounces of water; and two-thirds of the whole quantity of sugar present in a solution can be separated.

(*b.*) *Maumene's Test.*—Soak strips of woollen rag in a solution of perchloride of tin—one part of perchloride to two parts of water—for four or five minutes. Dry the slips over a water-bath. Let fall a drop of the suspected urine on one of these prepared strips, dry it, and expose to the dull red heat of a spirit-lamp. If only a trace of sugar be present, a black spot appears.

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* See "Med.-Chir. Review," January, 1853. (Lionel Beale.)

† "Urinary Deposits," etc. Edited by Dr. Birkett.

(*c.*) *Chromate of Potash Test.*—Mix equal parts of neutral chromate of potash and solution of potash with the suspected urine, and boil; if sugar be present, a green colour—by the formation of oxide of chromium—is produced (Horsley). A modification of this test may be made:—A solution of bichromate of potash is decomposed by excess of sulphuric acid; mix this with the urine, and boil; a beautiful green colour appears. This reaction is not affected by urea, the urates, or albumen (Luton).

To Estimate the quantity of Sugar.—By the *Fermentation Test*, the quantity of sugar present in diabetic urine may be estimated according to either of two of the results of this process:—

(*a.*) *By measuring the volume of Carbonic Acid produced.*—The mixture of yeast and urine is placed in a graduated tube, inverted over mercury. When the fermentation is finished, in from six to twelve hours, at a temperature of 100° Fahr., the volume of gas formed is thus indicated, and subject to correction for temperature and pressure, the amount of sugar can be calculated. One cubic inch of carbonic acid represents nearly one grain of sugar.

(*b.*) *By the diminution in specific gravity or weight of the Urine, after destruction of the Sugar by complete fermentation; as compared with the weight before this process*—Dr. W. Roberts' method. The difference of specific gravity here indicates the quantity of sugar. Two portions of urine, of four ounces each, are placed in separate bottles of about twelve ounces capacity. In one is placed a piece of German yeast, the other is tightly corked. Both are placed in a warm place for twenty-two hours, until fermentation is complete. The bottles are removed to a cooler locality, and after two hours the density of the fluid in each bottle is tested by the urinometer. Every degree of density lost, by the fermented sample, indicates one grain of sugar in each fluid ounce of urine.

ALBUMEN IN URINE—ALBUMINURIA.—*Physical Characters of Urine,* in Bright's Disease.—Colour, smoky-brown; easily froths, owing to the presence of albumen; specific gravity low—averaging 1·014—by abstraction of urea. Quantity of urine much diminished, owing to the reduced proportion of water. Subsequently, the urine becomes pale and opalescent, and is less apt to froth, there being much less albumen: the specific gravity declines yet lower, down perhaps to 1·004, while the quantity of urine is increased, approaching even to diuresis. The reaction is, generally, much less acid than in health.

The specific gravity of the serum of the blood is reduced to 1·018 or even to 1·015, as compared with that in health, which ranges between 1·029 and 1·031.

Microscopical Characters.—Casts of the uriniferous tubules, blood, and perhaps pus, may pass in the urine, which presents accordingly characteristic appearances under the microscope; but their description scarcely relates to the composition of the urine secreted.

Chemical Tests.—The solid constituents of the urine, amounting in health to about 68 in 1000 of urine, in Bright's disease decline to 14, 12, or even 6 parts only in 1000. This is chiefly due to the abstraction of urea, alluded to in connection with the altered physical characters of the urine. The quantity of albumen contained in the urine varies exceedingly—from a mere trace, to possibly 545 grains in the twenty-four hours (Parkes).

The presence, or, as in the early stage it might be termed, the substitution of albumen for urea, is easily discovered and readily distinguished, provided only certain precautions be observed in making the examination.

They relate either to the chemical composition of the urine submitted to examination, or to the tests employed; chiefly, these precautions have reference to the urine itself.

Albuminous urine is not merely a solution of albumen. So far as it *alone* is concerned, by applying heat to such urine, the albuminous portion — white of egg — begins to coagulate at 160° Fahr., and gradually solidifies as the temperature rises to 120°. But this urine contains other ingredients, and their variations in quantity interfere with the coagulation of the albumen.

Thus, if the urine be alkaline, or even neutral—whether from the presence of volatile alkali, carbonate of ammonia, or from fixed alkali, as soda—either alkali will combine with albumen, and neither of the resulting compounds being coagulable by heat, the urine remains clear when heat is applied. The albumen is not discovered, although perhaps abundant. Or, again, if an opposite condition exists—should the urine be over-acid, from the presence of a free acid, as the acetic or hydrochloric, the acid will combine with albumen, and the acetate and hydrochlorate of albumen being uncoagulable by heat, the urine remains clear when heated. The albumen is concealed.

Supposing, however, that, on the application of heat, a white flaky precipitate does fall, resembling albumen, it may not be albumen. Earthy phosphates are likewise precipitated by heat. To distinguish between these two deposits—phosphates and coagulated albumen, as well as to evolve albumen concealed by an alkaline or over-acid state of the urine—heat having been applied, nitric acid (strong) should then be dropped into the test-tube, containing supposed albuminous urine. If the deposit be phosphates, they are redissolved; if albumen, it is more firmly coagulated.

Nitric acid *unaided* will precipitate albumen, but it also liberates lithic acid from the lithates, and combines with urea; when, therefore, either of these constituents is present in excess, a brown deposit of lithic acid or nitrate of urea forms and disguises the albumen. Both precipitates, however, together with the lithates, are redissolved by heat, which, on the contrary, discloses albumen.

In short, *heat* clears off any difficulty arising from lithic acid, the lithates, and urea; *nitric acid* clears off any difficulty arising from the (earthy) phosphates, at the same time liberating and evolving albumen from any prevailing alkaline or mineral acid condition.

Nitric acid, in respect of its behaviour to albumen, disputes with heat the privilege of disclosing the presence of this abnormal constituent of urine. Nitric acid unites with albumen, forming what may be called nitrate of albumen, which is not coagulable by heat. Consequently, if only just so much acid be added to albuminous urine as shall combine with all the albumen present and form this nitrate, none of the albumen will appear when heated. Nitrate of albumen, being *insoluble* in nitric acid, appears when *more* acid is added; but is again redissolved on the addition of an *excess* of acid. The happy *medium* quantity of acid is necessary to exhibit albumen,—not just an equivalent, which combining with the whole amount present, renders it insoluble, although heated; this would be too small a proportion of acid; while an excess—above that proportion in which the nitrate of albumen is insoluble—redissolves it.

To strike the balance, and moreover obviate all other possible difficulties to which I have referred, the right method of examining supposed albuminous urine is simply this :—Pour a *small* quantity—say, a fluid drachm—of the urine into a test-tube; heat it to the boiling point, and then drop in *two* or three drops only of strong nitric acid. If phosphates have been precipitated by the heat applied, they will be redissolved, and the white flakes of coagulated albumen appear more clearly. On being allowed to stand, it will subside in the tube, leaving the urine above clear; thus defining the quantity of albumen present in any given quantity of urine examined. This will be found, as already said, to vary between two extremes: a slight white cloudiness subsiding as a little flaky deposit, or part or the whole sample becoming solid and white, like coagulated albumen of an egg, in the tube.

To exactly Estimate the quantity of Albumen.—Either of the two following processes may be resorted to:—

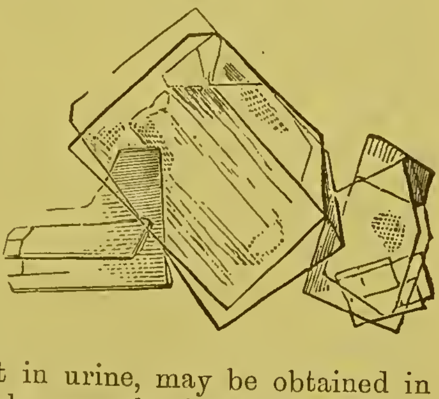
Take 500 grs. of the urine of twenty-four hours, and boil it in a flask, nitric acid being added subsequently, to secure coagulation of the albumen, and to dissolve any of the phosphates deposited by boiling. Then let the coagulated albumen subside by standing the flask, decant off the clear fluid, and throw the residue upon a weighed filter. Wash the collected albumen on the filter, with hot distilled water, to bring away saline matter; dry on the water-bath, and weigh.

Or, acetic acid may be added, in just sufficient quantity, and the urine boiled, thus to effect coagulation. The process is then completed in like manner.

Diagnostic Value.—The significance of albuminous urine in its *persistence*, which is pathognomonic of Bright's disease of the kidney. With rare exceptions, this disease is invariably accompanied with albuminous urine, and this condition of urine persisting is a sure sign of that disease, and of no other.

Temporarily, albuminous urine is associated with many other diseases, as in fevers, and obstructions to the circulation.

Fig. 871.



BILE IN URINE.—*Physical Characters of Urine.*—Colour, dark saffron, green, or black; leaving a bright yellow, or other stain, on white linen. Other characters are not peculiar.

Microscopical Characters.—Certain constituents of the bile, when present in urine, may be obtained in crystalline forms. Taurine, as regular hexagonal prisms, with four or six sided sharp extremities, the elementary form being a right rhombic prism. Crystals of cholesterine may also be found. (Fig. 871.)

Chemical Tests—are the most delicate means of detecting the presence of biliary *colouring matters*, when escaping by the urine in quantity too minute to be visible, or made visible by staining linen.

Nitric Acid.—Pour on a white plate, or sheet of writing-paper, a small quantity of the suspected urine, so as to form an exceedingly thin layer, and carefully allow a drop or two of nitric acid to fall upon it. An immediate play of colours, green and pink predominating, will, if the colouring matter of bile be present, appear around the spot where the acid falls.

Heller's Test.—Add to the urine any albuminous fluid—serum of blood or white of egg; then pour in sufficient nitric acid to produce a considerable albuminous coagulum. Examined after a short repose, it will present a bluish or green colour if bile pigment existed in the urine; whilst, if none were present, the deposited mass will be white or slightly yellow.

But albumen precipitated by nitric acid in urine, destitute of bile, is more or less coloured, bluish or reddish; this appearance arising from the action of nitric acid on the colouring matter of the urine—uroxanthine. Dr. Basham has observed this urinary coloured albumen most frequently in acute renal dropsy; and it is a very unfavourable sign.

Acetate of lead precipitates albumen, if present, in bilious urine, of a yellowish colour.

Colour of Phosphates.—After exposure of urine for a day or two, crystals of triple phosphate are deposited, having a yellow tinge. A very delicate and pretty test of bile colouring matter (Hassall).

For Bile Acids.—(*a.*) *Pettenkofer's Test:* To a small quantity of the suspected urine in a test-tube, two-thirds of its volume of sulphuric acid are to be carefully added, taking care that the mixture, which soon becomes hot, never exceeds a temperature of 144 degrees. Three or four drops of a solution of one part of sugar to four of water are then added, and the mixture shaken. A violet-red colour is developed if bile be present. This familiar test was not regarded favourably by Golding Bird. His experience led him to doubt its accuracy, and in applying it there are numerous sources of fallacy to be guarded against; chiefly, that the action of sulphuric acid on sugar develops a red colour in the absence of bile. A mixture of albumen or oil with sugar will, even in very minute quantities, under the action of sulphuric acid, produce a purple or scarlet colour, as Raspail long ago observed.

(*b.*) *Hoppe's Test*—for a *trace* of bile acid. Treat the suspected urine with excess of milk of lime, and boil for half an hour. Filter, and evaporate the clear fluid nearly to dryness, and then decompose with excess of strong hydrochloric acid. Boil the mixture for half an hour, renewing the acid from time to time, so as to prevent the spurting which would occur from over-concentration. Let the mixture completely cool, and then dilute with from six to eight times its volume of water. Filter with the turbid solution, and wash the resinous mass, until the water runs through quite colourless. Dissolve the residue in spirit, containing ninety per cent. of real alcohol, decolourize with animal charcoal, again filter, and evaporate to dryness over a water-bath. The yellowish resinous residue is pure *choloidic* acid. On warming it, a peculiar musk-like odour is emitted. Dissolve this resinous matter in a little caustic soda and warm water, add a little sugar, and let fall, slowly, three drops of concentrated sulphuric acid into the mixture. The resinous acid is at first precipitated; but afterwards, the flakes adhering to the glass are slowly dissolved by adding more sulphuric acid, and there appears an entirely clear fluid, of a beautiful *dark violet* colour (Virchow's "Archiv," vol. xiii.; "Archives of Med.," vol. i.). This test results from an elaborate process, but it is a very delicate and infallible one.

The following useful tables are from Dr. Golding Bird's work;* they contain reference to some deposits not hitherto described in this work, but which are here incidentally introduced :—

(1.) *Table for the Microscopical Examination of Urinary Deposits.*†

Deposit amorphous, and disappears on the addition of liquor potassæ.	Urates.
,, ,, and permanent on the addition of liquor potassæ.	Phosphate of lime.
,, visibly crystalline, and the crystals octohedral ‡ .	Oxalate of lime.
,, ,, ,, and the crystals hexagonal tables, soluble in ammonia	Cystine.
,, ,, ,, and the crystals prismatic or penniform, not soluble in ammonia, but in acetic acid . .	Neutral triple phosphate.
,, ,, ,, and the crystals radiated or foliaceous, not soluble in ammonia, but in acetic acid, with effervescence .	Carbonate of lime.
,, ,, ,, and the crystals radiated or foliaceous, not soluble in ammonia, but in acetic acid, without effervescence .	Bibascic triple phosphate. §
,, ,, ,, and the crystals dumb-bells, not soluble in ammonia, but in acetic acid, with effervescence . .	Carbonate of lime.
,, ,, ,, and the crystals dumb-bells, soluble by heat, but not in ammonia, nor acetic acid.	Lithate of soda.
,, ,, ,, and the crystals dumb-bells, insoluble by heat, ammonia, and acetic acid.	Oxalurate of lime. §
,, ,, ,, and the crystals dumb-bells, with fringed edges, insoluble in alcohol and acetic acid, but soluble in liquor potassæ.	Lithic acid.

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* "Urinary Deposits," etc. Edited by Dr. Birkett.

† The sediment may be *organized;* consisting of mucus, pus, epithelial cells from the genito-urinary passages, semen, blood, casts of uriniferous tubes, various other cells, and *débris* of tissue; or stringy, coagulable by acetic acid, and consisting of a tenacious matrix with cells, some small and round, others large and flat, with oval nuclei,—it is mucus; or consisting of spherical globules, not imbedded in a matrix, about $\frac{1}{1800}$ of an inch in diameter, studded with molecules and granules, and containing a double or triple mucus on the addition of acetic acid,—it is pus.

‡ Arsenious acid, chloride of sodium, and the protoxide of antimony, assume the octohedral form, but are rarely present.

§ Is not yet proved to exist in urine. (Thudichum.)

Deposits visibly crystalline, and the crystals lozenge-shaped or compound, insoluble in acetic acid and ammonia	Lithic acid.
„ „ „ and the crystals spherical, with or without spicules, soluble by heat .	Lithate of soda.

(2.) *Table for Discovering the Nature of Urinary Deposits by Chemical Reagents.*

Deposit white, and soluble by heat	Lithates.
„ „ and insoluble by heat, but soluble in ammonia.	Cystine.
„ „ and insoluble by heat and ammonia, but soluble in acetic acid	Earthy phosphates.
„ „ and insoluble by heat, ammonia, and acetic acid.	Oxalate or oxalurate of lime.
„ coloured, and visibly crystalline	Lithic acid.
„ „ and amorphous, but pale, and readily soluble by heat.	Lithates.
„ „ deeply, amorphous, and slowly soluble by heat.	Lithates stained by purpurine.

TREATMENT OF URINARY DISEASES, AND DEPOSITS.

The rational remedial treatment of any morbid condition is, essentially, the removal of the cause or causes in operation; its preventive treatment, their anticipation.

Lithic Acid, and Lithates—Treatment.—The pathological origin of lithic acid in excess is mal-assimilation, primary or secondary; or it denotes an excess of animal food over and above the wants of the system, which is accordingly expelled *in limine* from the blood through the kidneys, without having contributed to the nourishment of the body. Hygienic measures, therefore, are primarily important. A reduced proportion of animal food is obviously the leading curative measure, and active exercise daily to increase the elimination of any excess is equally necessary.

No remedial measures are at present known for directly correcting mal-assimilation in respect to lithic acid or other products. The effect of increased bodily exercise may be to increase the destructive metamorphosis of the highly nitrogenous textures, *i.e.* muscle, and thus directly increase the production of lithic acid; but this may also react beneficially in subsequently correcting the mal-assimilation.

Lithic acid passing off in the urine as lithate of ammonia is liable to be decomposed by the action of any free acid present in the urine; and lithic acid itself, being insoluble, appears as a deposit of reddish-yellow sand, consisting of crystals, which may aggregate and form a calculus. Hence the administration of *alkalies* to *neutralize* the acidity of the urine is indicated, of which bicarbonate of potash is, perhaps, the best for oft-repeated use. Other alkalies employed for this purpose are the bicarbonate of soda (as "Vichy water"), the acetates, tartrates, and citrates of soda and potash, phosphates of soda and ammonia, and borates of soda and potash. Conversely, the *removal* of any source of *acidity* is also indicated; but this refers again to hygienic considerations. With regard to food, the vegetable acids, or that which will form them, as sugar or starch in the food, should, in Dr. Bence Jones's opinion, be prohibited. On the other hand, free perspiration to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Warm clothing, warm bathing, friction with horsehair gloves and belt—an excellent skin stimulant—and diaphoretics, are most efficacious.

Lithate of ammonia being soluble in urine at the temperature of the body, its solution is thus secured, provided only that fluid be not overcharged. Dilution of the urine will best prevent supersaturation and deposit. The free use of aqueous drinks or soda-water is calculated to fulfil this indication, and thus probably prevent the formation of a lithate of ammonia calculus. Diuretics, which increase the secretion, will also aid the dilution of urine, and, moreover, tend to eliminate lithic acid or lithates from the system. The wine of colchicum, in doses of ten minims and upwards three times a day, prescribed with the carbonate of potash to keep the lithic acid in combination—the resulting lithates themselves being further held in solution by the administration of diluents—will together carry off both, and soothe the irritability of the bladder which accompanies their discharge. Saline aperients seem to contribute to this desirable result. Any prolonged subjection to such a course of elimination requires also the simultaneous action of small doses of blue pill, apparently to maintain the proportionate secretion of bile, which otherwise being virtually retained as compared with the secretion of urine, would disturb the balance of their constituents in the blood.

Preventive Treatment recognizes the same rules with regard to food and exercise; alkalies occasionally to intercept the deposit of lithic acid; and dilution to secure the solution of lithates.

Urea, excess in Urine—Treatment.—It should be remembered that urea—like uric acid, from which it may be derived—is produced physiologically in the system, by the destructive metamorphosis of the highly nitrogenous textures, *i.e.* muscle. Nitrogenous food is also, perhaps, a direct source of urea, and is assuredly followed by a rapid and very considerably increased production of this constituent of the urine. Its pathological origin is apparently similar; an excess being produced in connection with febrile conditions, and a deficiency in those of an opposite character. Consequently, the indications of curative treatment would appear to be: to lessen the daily toil and harass, which are well known to be associated with ureal diabetes, and, still guided by pathology, to reduce the supply of animal food. But this latter indication is not confirmed by experience. It is found necessary to repair the system by a generous diet, aided by tonics and alcoholic stimulants; the latter seeming to supply a material which readily oxidates, thus protecting the muscular tissue from premature decay, with that excessive production of urea which rapidly runs off through the kidneys and incessantly irritates the bladder. The quantity of urine, and thence the frequency and urgency of micturition, may be reduced by opium, which tends also to soothe the general nervous excitement that accompanies exhaustion of mind and body.

Preventive Treatment is necessarily guided by similar considerations only with an anticipatory application.

Phosphoric Acid and Phosphates—Treatment.—Guided by its pathological origin, an excess of phosphoric acid, in combination with alkaline or earthy bases, suggests, primarily, the endeavour to arrest, if possible, that destructive metamorphosis of nervous tissue which generates phosphoric acid in abnormal quantity. Consequently, temporary freedom, at least from all anxiety and corroding care—in short, mental relaxation—is primarily imperative. But the phosphatic diathesis is encouraged by vegetable food. A more animal diet, therefore, with beer and wine, is scarcely less imperative.

Deposition of the Phosphates—phosphatic urine implying, as it does, an alkaline state of this fluid—suggests the use of mineral acids. The nitric and nitro-muriatic acids, diluted, are the most useful. They are generally combined with vegetable tonics, as cinchona, and with apparent advantage. Opium also will aid in restoring acidity to the urine, besides subduing nervous excitement. Benzoic acid has been highly recommended, it being converted into hippuric acid during its passage through the system. The earthy phosphates, *i.e.* of lime and magnesia, are thus held in solution and become invisible; the alkaline phosphates, *i.e.* of soda and potash, never appearing. But the deposition of the former is effected by an excess of *fixed* alkali—soda or potash—in the urine. Another occasion of phosphatic urine is an inflammatory state of the urinary mucous membrane, with the secretion of mucus, which, acting apparently as a ferment, induces the decomposition of urea and liberation of carbonate of ammonia—a *volatile* alkali. The urine thus becoming alkaline, deposits the triple phosphate of ammonia and magnesia with phosphate of lime. As regards the mere deposition of these (earthy) phosphates, mineral acids will, in like manner, counteract this tendency. Alkalies, however, have been recommended by Dr. Owen Rees, with the view of reducing the acidity of the urine as secreted, thus preventing its irritating the mucous membrane of the bladder. Less mucus is secreted; and the urine in the bladder actually becomes more acid.

Preventive Treatment is determined by precisely the same considerations respecting the generation of phosphoric acid in excess, and thence the formation of phosphates in excess; and also respecting the deposition of (earthy) phosphates in the urine, whether by fixed or volatile alkali.

Oxalic Acid, and Oxalates—Treatment.—Considering the certain pathological origin of oxalic acid in excess, by the primary mal-assimilation of sugar and sugar-forming food, such food is contra-indicated. Every species of vegetable food is questionable; and those which contain oxalic acid, *e.g.* rhubarb, sorrel, onions, and tomato, or certain medicines, *e.g.* alkaline salts with a vegetable acid, are unquestionably forbidden. Considering also the probable production of this acid in excess, by the destructive metamorphoses of the nitrogenous tissues in secondary mal-assimilation, and its association with, or derivation from, lithic acid, a nitrogenous diet would seem to be contra-indicated. Nevertheless, experience shows that animal food, with brandy-and-water instead of beer or wine, form a suitable diet; but the water should be distilled, to deprive it of lime, with which the oxalic acid otherwise combining would lead to the formation of a urinary calculus.

Appropriate medicinal treatment will aid regimen. The mineral acids are efficacious, particularly hydrochloric and nitro-muriatic acids, in conjunction with bitters. They were recommended by Dr. Prout to be taken daily for about a month, or until lithic acid or lithates reappeared in the urine. "By adopting," said he, "such a course of acids three or four times in the year, and by a carefully regulated diet, I have seen this diathesis gradually subdued, and at length removed altogether." Irritability of the bladder, in connection therewith, is not unfrequently subdued by the compound tincture of camphor; indeed, Dr. Bence Jones speaks of this remedy as having thus proved "very useful."

The association of oxalate of lime with uric acid, in the urine, requires the anomalous administration of both acids and alkalies. In such cases, supposing the deposit of oxalate to be considerable and persistent, Dr. Hassall suggests that it should be treated in the first instance. If the uric acid deposit be constant and in large quantity, alkalies and acids may sometimes be administered with advantage alternately.

Preventive Treatment will consist in the avoidance of those articles of food which are apt to produce or actually contain oxalic acid, and in the observance of the suitable diet. Conjointly, the precautionary use of the appropriate medicinal measures, occasionally.

Sulphuric Acid—Treatment.—Animal and vegetable food having, apparently, equal influence in producing an excess of sulphates in the urine, no distinction can be drawn favourable to either kind of diet, as a remedial agent. But as sulphur is disengaged by the destructive metamorphosis of the nitrogenous tissues chiefly, and subsequently, by oxidation, converted into sulphuric acid, active exercise, which increases both these changes, is contra-indicated. Repose, and the requisite remedial measures for subduing febrile excitement, are, perhaps, the general indications to be fulfilled. Eliminative treatment would, of course, be curative, by removing the excess of sulphuric acid from the system; but the present state of knowledge in this respect is here, as with regard to other blood-conditions, too unsettled for practical purposes.

Preventive Treatment will consist in the anticipation and avoidance of the causative conditions above alluded to.

Hippuric Acid—Treatment.—This highly carbonaceous acid is produced in excess—either by vegetable food, itself too rich in carbon, or by medicine containing benzoic acid; perhaps also by the destructive metamorphosis of nitrogenous tissue, in secondary mal-assimilation; or by defective elimination of carbon through the liver, lungs, or skin. But little is known respecting remedial measures. The substitution of nitrogenous food, increased exercise, and the administration of medicines to increase the secretion of bile and sweat, would seem to be the most hopeful.

Preventive Treatment is guided by similar considerations.

Lactic Acid—Treatment.—The pathological origin of this acid, in excess, is obscure. Food abounding with lactic acid, introduced by primary assimilation, is undoubtedly one source. Of such kinds of food are—milk and vegetables which have become sour, and sugar or amylaceous food which may be converted into lactic acid. But an excess would also seem to arise, in some cases, from the destructive metamorphosis of muscular tissue,—in secondary mal-assimilation;

that tissue everywhere abounding with lactic acid. Mal-excretion through the skin is another alleged cause; the sweat, it is said, containing lactic acid. Hence the imputed pathological origin of rheumatism. Defective respiration is also an apparent cause; lactic acid by oxidation being readily converted into carbonic acid.

Taking these facts and opinions into consideration, the indications of treatment are: to correct any error of diet, to moderate bodily exertion, to maintain or increase the functions of the skin by warm clothing; and to render the respiration more active, by daily exercise, when the excess of lactic acid arises apparently from an opposite condition, in this respect.

Preventive Treatment, as usual, consists in the anticipatory observance of the curative indications.

Chlorides—Treatment.—Introduced into the system by most articles of food—in the course of primary assimilation, and disengaged from the tissues, by destructive metamorphosis in secondary assimilation, an excess of clorides in the blood and urine proceeds either from the food, or increased transformation of the textures. Vegetable food in general contains a much larger relative amount of the chlorides—of sodium and potassium—than animal food; and the component proportion of these salts in the various tissues of the body, is also different and variable. Exercise of body and mind, affecting chiefly the muscular and nervous systems, increases the chlorides in the urine. The remedial indications are obvious: an increased proportion of animal food, and rest.

Preventive Treatment is analogous, but anticipatory.

Sugar in Urine—Treatment.—This abnormal constituent of the urine may proceed, perhaps, from various sources—mal-assimilation, primary or secondary; but chiefly from imperfect oxidation and destruction of the sugar-glucose produced in the liver, itself transformed glucogen, also produced in that organ. This, which is Bernard's theory, founded on experimental observations, is disputed by Dr. Pavy, whose observations led him to regard the transformation of glucogen ("hepatine") principally as a *post-mortem* change; but this again is denied by Dr. Harley, whose investigations may, therefore, be regarded as indirectly supporting the views of Bernard.

The imperfect oxidation of sugar is not apparently connected with deficient respiration.

Besides this natural origin of diabetes mellitus, there is also the accidental origin from injury to the medulla oblongata, and the floor of the fourth ventricle, and to the sympathetic system of nerves.

Bearing in mind the pathological origin of this disease, the indications of treatment relate to diet rather than medicine. No known medicinal measures have hitherto proved essentially efficacious; but the disease can be controlled, and for an unlimited period, by an appropriate diet.

The rule to be observed is—a scrupulous avoidance of every kind of food containing sugar, or which can be converted into sugar. Rigorous abstinence is not equally imperative in every case, yet the indication is the same.

Animal food, therefore—including fish of all kinds, and eggs—is quite unobjectionable; while of vegetable food, the choice is restricted to greens, bran bread or cake, and such articles as do not belong to the saccharine class of ailments. Of liquids, brandy-and-water, tea, and coffee are safe.

The diabetic bill of fare does not allow of much variety, and constant self-denial is required to keep within its bounds. Nevertheless, certain indulgences may be employed with impunity; and, so far as the personal experiences of *one* diabetic patient in particular affords adequate information for the guidance of others, Mr. Camplin's observations * respecting himself are valuable and encouraging.

Genoa maccaroni proved to be one of the best substitutes for the bran-cake. Milk need not be forbidden. Cruciferous vegetables afford many agreeable varieties—cabbage, cauliflowers, broccoli, Brussels sprouts, etc.; sea-kale and spinach are quite harmless; onions are allowable, and in most cases turnips. Lettuces agreed when eaten sparingly with oil and vinegar. Tea is preferable to coffee, and with it milk may be taken freely, cream only in small quantity. Cocoa is allowable if prepared from the "nibs," not that which is sold in cakes or powder. Pale French brandy should be taken, but only in measured quantities, say a tablespoonful with water. Wines are better excluded, excepting claret, which is a most suitable beverage.

Other hygienic means were very advantageous. Sponging with tepid water, followed by friction, proved highly beneficial; so also sponging with cold salt and water in summer, and an occasional warm bath in the winter. Warm clothing, a leather waistcoat, and gutta-percha soles to the boots in winter, appear equally important. Change of air and occupation were so favourable, that wheaten bread was substituted for the bran-cake during the period of relaxation.

A few words respecting medicinal treatment will suffice. Free perspiration affords some relief to the diuresis. Besides, therefore, the sudorific appliances just alluded to, the salts of ammonia are serviceable; the sesquicarbonate is an exception, at least it was so in Mr. Camplin's case. Citrate of ammonia, combined with citrate of iron, was useful. Bitters and alkalies proved very beneficial. Opiates are valuable in some cases as a temporary means of checking the secretion of urine, and allaying irritability of the bladder.

Preventive Treatment.—Such also are the preventive measures—dietetic chiefly, hygienic and medicinal subserviently—by the early and patient employment of which diabetes may be kept in subjection, and for an unlimited period. By their instrumentality Mr. Camplin not only rescued himself from a deplorable state of health, but was preserved from the ever-threatening recurrence of this disease during a period of no less than fourteen years.

Cod-liver oil in large quantities—seven or eight ounces daily—is highly recommended by Dr. Bence Jones, in cases of considerable emaciation.†

Albumen in Urine—Treatment of Bright's Disease.—The retention of urea and water, in the blood, with the discharge of albumen in the urine; and subsequently the proportionate exchange of water for albumen in this secretion, while the retention of urea in the blood progressively increases;—these are the changes in the relation of the blood and urine, which are essentially of therapeutic importance. Nutriment in its best form—albumen—is incessantly draining away from the blood; while effete and noxious matter—urea—representing the decay of the textures, is constantly retained; thus conceding the powers of life to the dominion of death. Besides the symptoms incident to this double process of destruction—by starvation and blood-poisoning, both of which are faithfully represented by the condition of the urine—general dropsy supervenes, owing to the retention of the water, which infiltrates the cellular texture throughout the body,—presenting an additional symptom.

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* "Med.-Chir. Trans.," vol. xxxviii.

† "Stomach and Renal Diseases." Case p. 122.

The curative indications of treatment are—to reverse, if possible, the relative conditions of the blood and urine, and thus restore the condition of health.

Cupping or blisters on the loins will tend to remove renal congestion—in the early stage of nephritis; but the perilous state of the kidneys forbids any direct attempt to restore their function. Subsequently, diuretics may be tolerated, and then prove serviceable. Digitalis, squills, or the tincture of cantharides, cautiously administered, are perhaps the most efficacious. The pill originally prescribed by the late Dr. Baillie is an admirable formula. It consists of powdered digitalis, half a grain, and squills, one grain, combined with three grains of blue pill; to be taken two or three times a day.

Palliative treatment will have for its object the discharge of water, which has accumulated in the system, by other channels than the kidneys; *i.e.* through the bowels and skin. Hence, hydragogue cathartics, *e.g.* elaterium, croton oil, gamboge, jalap with cream of tartar; and diaphoretics, *e.g.* citrate of ammonia, the compound powdered ipecacuanha (Dover's powder), and hot-air or sweating baths; are singly, conjointly, or in succession, often remarkably useful and comforting.

A generous diet, consisting of an increased proportion of albuminous food, as in the form of eggs, is especially necessary in the chronic disease, to replace the albumen which has been lost, and is still passing away; with tonics also to support the circulation. The preparations of bark are thus effectual, but those of iron more so, for in no disease, perhaps, are the red corpuscles of the blood so reduced.

Preventive Treatment has reference rather to the *causes* of that primary alteration of renal structure, whence the pathology of the blood and urine proceed. Those causes are preventible, in most instances. Scarlatina is an occasional cause—rarely, however, a productive one, unless brought into operation by cold. After scarlatina has run its course, the residue of poison remaining in the blood appears to be naturally expelled by the kidneys, imposing extra functional duty on these organs; yet they generally fulfil their appointed task, unless when thus congested—bordering on inflammatory excitement—exposure of the body to *cold* should further impose an additional and intolerable burden. Then, under the pressure of extreme congestion, albumen is filtered off, urea retained, and febrile dropsy supervenes. This additional strain on the excretory power of the kidneys, and its results, aro obviously preventible. So also the more prevalent intemperate use of spirituous liquors imposes extra work on the kidneys; but even this strain may be made for years with impunity, although a hazardous experiment. Exposure to cold, however, becomes intolerable; it provokes albuminuria.

Such is the usual etiology of this disease, as originally investigated by Dr. Bright,* and which the experience of other observers has since confirmed: "intemperance seems its most usual source, and exposure to cold the most common cause of its development." †

Bile in Urine—Treatment of Jaundice.—The retention of bile in the blood circulating, and thence its effect on the system at large,—of which the escape of biliary colouring matter in the urine is symptomatic,—is the pathological condition of therapeutic importance. But this again has reference to the structural conditions of the liver or adjacent organs, by which such retention is effected. These causative conditions are — either mechanical, by obstruction, in the ducts or externally, to the free flow of bile into the duodenum, thus permitting the absorption of the bile imprisoned; or, some structural disease of the liver,—arrest of secretion being then the immediate cause in operation, thus preventing the elimination of biliary constituents from the blood. Without any structural disease of the liver itself, arrest of its secretion may also be caused by various morbid states of the blood or of the nervous system, which, severally, paralyzing the function of this organ, induce jaundice.

The indications of treatment which may be gathered from the pathology of jaundice are of different practical significance and hopefulness. If the retention of bile be due to some mechanical obstruction only, that causative condition may cease spontaneously. An impacted gall-stone will most probably pass, in the course of time; or the pressure, externally, of any adjacent organ enlarged by disease, may itself be relieved from time to time. Repeated opiates, or the warm bath, will also tend to soothe and relax spasm, in the one case; and an accidental turn in the course of the disease may bring relief in the other. But with structural disease of the liver itself, remedial measures become necessary, yet the result is less hopeful. An appeal to the secretory power of the liver may have a satisfactory response, and thus the administration of the cholagogue purgatives, large doses of blue pill or taraxacum, with salines to unload the portal circulation, may be advisable. Arrest of secretion by the influence of various blood-poisons, or powerful mental emotions, or the shock of bodily injury, affecting the nervous system, are cases scarcely within the reach of medicine. Thus, jaundice arising, occasionally, from pyæmic infection of the blood, from poisoned wounds, and from various fevers, subsides only as the morbific matters in operation are eliminated through other channels of excretion.

Preventive Treatment.—The appropriate preventive measures with regard to each of the blood-diseases, the causes and treatment of which we have now considered, are at once suggested by reference to the causes themselves.

Temperature is the main question to be considered in reference to the prevention of *jaundice.* Not that other etiological conditions are unimportant, but they are for the most part beyond our control.

A hot climate *predisposes* to jaundice by enfeebling the circulation and inducing congestion of the liver. It is probable also that diminished oxygenation of the blood, through habitually breathing a hot atmosphere, aids this effect on Europeans, prior to their acclimatization. Hydro-carbonaceous matter, ordinarily eliminated by the lungs, accumulates in the blood, and the liver is proportionately overtaxed—a burden increased by indulging in stimulating liquors, especially malt beverages, which, abounding with hydro-carbonaceous matter, fall heavily on this organ, and further tax its functional power beyond endurance.

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* "Reports of Medical Cases selected with a view of illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy," 1827, vol. i. p. 3.

† "Guy's Hosp. Rep.," 1836, vol. i. Cases and Obs. illustrative of Renal Disease, accompanied with the secretion of Albuminous Urine, p. 339.

Such being the predisposing influences of high temperature, any change of temperature approaching to cold is the *immediate* or exciting cause of jaundice. In *every* case, Sir Ranald Martin affirms,* that he has seen in England amongst those who have returned from India, cold has been the immediate cause of this disease. Taking seventy-two cases of icterus typhoides, by Lebert, one-third occurred in November and December.

The preventive measures suggested by these observations are plain. They are most important to persons about to visit any tropical climate. Although unavoidably subjected to the physiological influences of heat, certain precautions are available. Prudent moderation in the use of stimulating beverages, and the careful regulation of clothing, should be rigidly observed. Besides adequate protection against the vicissitudes of external temperature, the cautious indulgence of cold drinks—iced beverages—is an injunction not to be forgotten. On returning home, after residing for some time in a tropical climate, it is advisable, if possible, to pass the ensuing winter in a more even climate than that of England. And when residing again in this country, these precautions, especially with regard to vicissitudes of temperature, should still be observed.

URINARY CALCULI.

Urinary Calculus, or stone, signifies a concretion of one or more of the constituents of the urine, forming a hard mass.

Origin.—It originates from the precipitation of urinary constituents, as Urinary Deposits, in consequence of a loss of solvent capacity in the water of the urine. This may arise in one of three ways: by an excess of any substance for the water to dissolve; by a deficiency of water for solution of the substance; or by the presence, or absence, of some third substance. In either way, different natural analyses of the urine occur; precipitating urinary deposits, and resulting in the formation of urinary calculi.

Production.—The deposit may aggregate from a focus of its own substance; more frequently it gathers around a foreign body as a distinct nucleus; in either way producing a calculus. In the former mode of production, aggregation is due either to an excess of insoluble constituents and thence their immediate precipitation, as in the ordinary forms of uric acid, urate, and oxalate concretions; or, to retention of the urine in the bladder,—in consequence of paralysis, chronic inflammation and hypertrophy of the organ, enlargement of the prostate, or stricture of the urethra, all of which conditions severally lead to the retention of urine, and perhaps affect its chemical constitution,—as in the formation of phosphatic calculi. When a calculus forms around a distinct nucleus, this is some foreign body; either a small clot of blood or mucus derived from the urinary organ in which the calculus originated, or it may be some small foreign body introduced from without into the bladder through the urethra, or by wound or ulceration of the organ.

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* "Influence of Tropical Climates in producing the Acute Endemic Diseases of Europeans," 2nd ed., 1861.

The constituents of a calculus are held together by some kind of cement, which is believed to be animal matter; mucus, fibrin, or fatty matter; or it is said, possibly blood, epithelium, or even pus.

The *seat* of origin in the urinary organs may be either the kidney or the bladder, and thence a calculus is designated *renal* or *vesical;* usually it originates in the kidney, and subsequently descends as a small stone into the bladder, where it increases by further concretion.

Urinary calculus differs in its physical characters and chemical composition; thus representing different classes and species of Urinary Calculi.

Physical Characters.—Urinary Calculus varies in point of size, shape, weight, colour, odour, consistence, structure on section, and number. The *size* is extremely variable; from that of a hemp-seed, pea, nut, or almond, to a cricket-ball and occupying the whole cavity of the thickened bladder. Of such large-sized calculi, one may be seen in the Museum of the Royal College of Surgeons, and another in the valuable collection of the Norfolk and Norwich Hospital Museum. That in the College collection measures sixteen inches around its long axis, and fourteen inches around its short axis; it weighs forty-four ounces. An unsuccessful attempt was made by Mr. Cline to remove it from Sir Walter Ogilvie, who died on the tenth day. A nearly similar sized stone was removed by Uytterhœven, of Brussels, by the high operation. Phosphatic calculi usually attain the largest size. The *shape* also varies remarkably, and principally according to the situation and composition of the stone. Renal calculus is irregular, and often moulded to the form of the calices and pelvis of the kidney; in the ureter, a stone is generally cylindrical; the vesical is more uniformly of a flattened ovoid shape, or globular; while the prostatic is pear-shaped or singularly faceted. In relation to composition; uric acid and urate of ammonia calculi are usually smooth and regular; the oxalates tuberculated like a mulberry,—hence the common name of this calculus; the phosphatic may be smooth and regular, or irregularly contorted. Many other forms are met with, which being readily recognized, need not be specified. The *weight* depends more on the composition than the size of the stone; the phosphatic being very light, the oxalates very heavy, and uric acid or urates between the two. The average weight is an ounce; but extremes have been met with—in a stone of ten grains taken from a boy; another of nearly six ounces, removed by Sir A. Cooper; and another of thirty-two ounces, in the Museum of Trinity College, Cambridge. Of heavy calculi not removed, Deschamps saw one that weighed fifty-one ounces; and Morand one weighing six pounds—the heaviest on record. The *colour* of a calculus represents only the chemical nature of the surface or external crust of deposit; the interior is often very different. A white surface signifies a phosphatic crust; a cinder-grey, that of urate of ammonia; a yellow pale brown, or brown, the uric acid; cinnamon-brown, the uric or xanthic oxide; a mahogany brown, brownish or blackish green, the oxalate of lime; a grey-greenish or slate colour, the cystic oxide.

The *odour* of a recently extracted calculus is sometimes peculiar. Phosphatic calculus may be ammoniacal, and oxalate of lime, on section, is said to emit a faint odour of semen. An aromatic smell, as of castor or musk, is sometimes perceptible. The *consistence* varies from that of mortar or sand to that of granite. But this will depend on the chemical nature of the calculus and on the intermixture of organic matter, or moisture in a recently extracted stone. Phosphatic calculus is generally soft; the uric acid hard; and the oxalates very hard. The crust is usually softer than the interior, and the nucleus has the densest consistence. A rapidly formed stone is softer than one of slow production.

Structure.—On *section*, a calculus generally presents a nucleus, and the surrounding concretion, which has a more or less distinct external crust. The colour and consistence of the section may be uniform, when the stone consists of only one chemical constituent,—forming a *simple* calculus; or it varies in appearance at different depths, when consisting of different elements,—forming a *compound* calculus. The disposition of the concrete matter may be continuous,—presenting no visible arrangement; but usually it is deposited in concentric layers or laminæ, and sometimes lines radiate from the centre to the circumference of the stone. Varnishing the dried surface will exhibit its appearance most distinctly. This laminated arrangement corresponds apparently to the successively active periods of urinary deposit. Such is Prout's explanation; and it would seem, therefore, that a continuous concretion must be due to an uninterrupted deposit. Lamination may occur in the formation of both a simple and a compound calculus. It depends apparently on varying states of the urine. When some length of period intervenes in the deposition of matter, the surface of the concretion becomes water-worn, and worm-eaten; fresh deposition is less firmly adherent, and consequently a calculus thus constructed is disposed, when broken, to split into its concentric laminæ. In compound calculus, the successive deposition of different matter may be in a regular *alternation.* The *nucleus* is situated usually in or near the centre of the calculus; sometimes it is very eccentric, as in some renal calculi. Occasionally, more than one, or possibly several nuclei, may be found, as distinct centres of concentric deposition. More rarely, the nucleus is loose within the substance of the calculus; owing apparently to a layer of blood or mucus having gathered around the nucleus, and then the concretion taking place on this layer. When the organic matter dries and pulverizes, the nucleus is left loose in the stone. Lastly, the nucleus may have disappeared, leaving a central cavity; a result probably of the nucleus itself having been blood or mucus, which has undergone disintegration.

The *differential* physical characters of the various species of Urinary Calculi are indicated in the following tabular view, which presents a useful analysis of the description given with regard to the different species of Calculi, severally. The student will thus learn to recognize more clearly the most essential distinctive appearances, as well as the individual characteristics, of each form of Calculus.

(I.) TABLE INDICATING THE PHYSICAL CHARACTERS OF URINARY CALCULI.

Arranged in the Order of their Chemical Affinity with regard to Tests. (See TABLE II.)

	Colour.	*Shape.*	*Size.*	*Weight.*	*Consistence.*	*Section.*
Uric or lithic acid.	Brown, light, or dark.	Ovoid and flattened.	Pea to orange.	Heavy.	Hard; fractured into sharp angular fragments and crystalline.	Concentric laminæ, radiating lines from nucleus.
Urate of ammonia.	Clay or slate, or reddish brown.	Ovoid, smooth, or tuberculated.	Small.	—	Fracture earthy (not crystalline).	Homogeneous.
Uric or xanthic oxide; very rare.	Cinnamon.	Flattened.	Small as pullet's egg.	—	Hard; fracture not crystalline.	Laminated.
Cystic oxide or cystine; rare.	Yellowish brown; grey-green or slate after long exposure; and waxy, glistening, slightly transparent.	Round, smooth, or tuberculated.	Small.	—	Soft and pulverescent; fracture crystalline; powder is white.	Homogeneous, with imperfect radiation.
Fibrinous calculus; rare.	Yellow.	Pea-shaped.	—	—	Fracture vitreous and lustrous; like yellow wax.	
Uro-stealith; very rare.	Resinous or fatty bodies.	—	Small.			
Blood-calculus; very rare.	Disintegrated blood-corpuscles, with phosphate of lime; black colour.	—	From coriander-seed to horse-bean.		Friable; fracture amorphous.	Amorphous; dark rusty.
Carbonate of lime; very rare.	White or ash.	Spherical or irregular.	Pea to nut, or larger.	—	Soft and friable; or very hard; fracture amorphous.	No concentric laminæ, or imperfectly lamellar.
Oxalate of lime, or mulberry calculus.	Dark brown or blackish green.	Spheroidal, tuberculated, angular, or spinous; rarely smooth.	Marble to horse-chestnut.	Very heavy.	Very hard; fracture crystalline.	Imperfectly laminated in irregular waved lines.
Varieties; rare.						
Hemp-seed calculus.						
Crystalline.	White-brown.					
Ditto.	Pure white.					
Phosphate of ammonia and magnesia. Triple Phosphate.	White or grey.	Irregular; somewhat spiculated.	Large probably.	—	Friable fracture, perhaps crystalline.	Imperfectly laminated.
Phosphate of lime; renal origin.	Pale brown.	Spheroidal and smooth.	Small.	—	Friable.	Laminated.
Bone-earth phosphate; vesical origin.	—	Irregular masses, or granular semi-crystalline powder in tenacious mucus.				
Phosphate of magnesia and ammonia, with phosphate of lime. Mixed phosphates. Fusible calculus.	White, grey, or dull yellow.	Very irregular; moulded to locality; sometimes globular or ovoid; or in pieces, cubic or tetrahedral.	Large probably.	—	Very friable or pulverescent, or soft, like moist chalk.	Concentric laminæ, or semi-crystalline, or amorphous, according to proportion of phosphates.
Silicious calculus only in other calculi						

The *number* of calculi varies chiefly according to the seat of the stone. In the bladder, usually there is only one; in the kidney, two or more; and in the prostate, several. Vesical calculi are, however, sometimes numerous; two to six or eight are not very uncommon, and instances are on record of 117; 142 about the size of marbles, were removed by Sir A. Cooper; 307, 678, and even 1000 have been found—the latter number having been extracted by Dr. Physick from an American judge. This number is the largest on record; the stones varied in size from partridge-shot to a bean.

Chemical Composition.—In regard to their essential constituents, urinary calculi, like deposits, may be divided into two classes; a third class represents the more rare forms. (1.) Calculi consisting of uric acid and the urate of ammonia; with their varieties, the oxalate of lime, uric or xanthic oxide, and cystic oxide or cystine. (2.) Phosphatic calculi, in all their varieties; as phosphate of ammonia and magnesia, phosphate of lime, and mixed phosphates of lime, magnesia, and ammonia,—constituting the fusible calculus. (3.) The fibrinous urostealith, carbonate of lime, and silicious calculi.

Urinary calculi may be severally *distinguished* both by their physical characters, and by chemical tests; sometimes also by the crystalline forms of their constituents, as shown by microscopical examination.

Physical properties are most readily recognized, but they are least definite and distinctive; Calculi will, therefore, be described in the order of their chemical relationship, with regard to *Tests.*

(1.) *Uric, or Lithic Acid Calculus.*—The most common of all calculi is that consisting of lithic acid. It was discovered by Scheele, in 1776. Its colour is generally light brown, varying however from pale brown to dark brown; and sometimes whitish on the surface, owing to its having become coated with amorphous urate of ammonia or with phosphate of lime. The shape is usually ovoid, and somewhat flattened; the surface smooth, or beset with small tubercles, so as to resemble the surface of oxalate of lime calculus; the size varies from that of a pea to an orange, and its consistence is hard according to the purity of the calculus; sometimes emitting a ringing sound on percussion, and breaking up into sharp angular fragments. The calculus, on section, is found to be composed of concentric laminæ, and exhibits lines or fibres radiating from the centre to the circumference of the stone; both these appearances are marked in proportion to the purity of the calculus, and determine the lines of fracture when the stone is broken. The nucleus may be quite white, although consisting of pure uric acid; owing, as Dr. G. O. Rees has shown, to the absence of colouring matter. The fracture is crystalline. *Tests:*—Combustible, and destroyed by heat; turned red by nitric acid, forming a murexide; soluble in carbonate of potash, evolving *no* ammonia.

(2.) *Urate of Ammonia Calculus.*—This is not a common form of calculus, urate of ammonia being soluble in warm urine; and it is generally confined to children. It was discovered by Fourcroy and Vauguelin in 1798. The colour of this calculus is that of clay or slate, and pretty characteristic, but less so when inclining to red or brown; it has an ovoid shape, and a smooth or slightly tuberculated surface, and is of small size; the section is homogeneous, seldom presenting a distinctly concentric laminated condition. Fracture is earthy

—not crystalline. *Tests:*—Combustible, and destroyed by heat; turned red by nitric acid, forming a murexide; soluble in carbonate of potash, evolving ammonia.

Urates of *Soda* or *Lime* are not found as calculi; these urates are mixed with urate of ammonia or uric acid in compound calculi.

(3.) *Uric or Xanthic Oxide.*—A very rare calculus, four specimens only having been recorded. It was discovered by Dr. Marcet in 1815. The calculus has a cinnamon colour, a somewhat flattened shape, and small size—resembling a flattened pullet's egg, in a stone examined by Stromeyer; its texture is hard and laminated. Fracture not crystalline. Uric oxide bears a close relation to uric acid, and results apparently from an imperfect oxidation of the chemical material which forms uric acid. *Tests:*—Combustible, and destroyed by heat, but not turned red by nitric acid; soluble in ammonia, *not* crystallizing when evaporated; insoluble in carbonate of potash.

(4.) *Cystic Oxide, or Cystine Calculus.*—This also is a rare calculus, discovered by Wollaston in 1810. It has a yellowish-brown colour, approaching that of the uric acid calculus, but after long exposure, it changes to a peculiar grey-greenish or slate colour; there is also a characteristic waxy, glistening, and slightly transparent appearance. Rounded and smooth, or tuberculated, and of small size, the consistence is soft and pulverescent; a section exhibits no tendency to concentric laminæ, and only very imperfect radiation. The fracture is crystalline; powder scraped with a knife is perfectly white, whether the stone be brown or green. Hereditary disposition to the formation of this calculus is strongly evinced; in twenty-two cases, ten occurred in four families, and in three cases the subjects were brothers. Cystic oxide calculus differs from all others chemically, in containing a large proportion of sulphur—about twenty-six per cent. It originates in the kidney, and not in the bladder, as its name might imply. *Tests:*—Combustible, and destroyed by heat, but not turned red by nitric acid; soluble in ammonia, crystallizing when evaporated in six-sided plates; soluble in strong caustic potash.

(5.) *Fibrinous Calculus.*—Described by Dr. Marcet and Dr. Prout, this rare calculus, so called, seems to have occurred in the form of pea-shaped bodies, of a yellow colour, and consisting of dried, coagulated albuminous matter. It can scarcely be regarded as a concretion; although such masses have presented considerable lustre on section, and a vitreous fracture, resembling yellow wax in appearance. *Tests:*—It may be distinguished from cystine, by being soluble with difficulty in ammonia, and not crystallizing when evaporated.

(6.) *Uro-Stealith Calculus.*—Another very rare pseudo-form of calculus, consisting of resin or fatty matter. It was originally described by Heller in 1844; several small bodies of this kind having been passed by a man, aged twenty-four, who suffered from symptoms of stone. Since that time, Dr. Moore of Dublin has examined several specimens sent to him by Dr. Robert Adams. *Tests:*—Soluble in ether and caustic potash; insoluble in boiling water, and nearly so in alcohol; when heated and melted, the odour of benzoin is emitted.

(7.) *Blood-Calculus* consists apparently of disintegrated blood-corpuscles associated with phosphate of lime; it therefore represents another form of pseudo-calculus, and which is also very rare. Described by Dr. Alison, and examined by G. O. Rees, a few such calculi were found in the pelvis of the kidney of a man who died of consumption. They had a black colour, and ranged in size from a coriander-seed to a small horse-bean; they were friable, and the fractured surface showed an amorphous, dark rusty appearance. *Tests* seem to have elicited nothing peculiar; the calculus matter was partly combustible, and soluble in liquor potassæ.

(8.) *Carbonate of Lime Calculus.*—An extremely rare form of calculus, discovered by Brugnatelli in 1819. Of a perfectly white or an ash-colour, spherical or irregular, and varying in size from a pea to a nut, or larger, the consistence is usually soft and friable, but sometimes very hard. Section shows no concentric laminæ or only an imperfect lamellar structure. The texture is amorphous. Prostatic calculi consist almost entirely of carbonate of lime, as Dr. Thudichum has demonstrated; but it is always doubtful whether the lime or the carbonic acid were in any case derived from the urine. *Tests:*—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *before* heating; solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.

(9.) *Oxalate of Lime Calculus.*—This is the next most common after the uric acid calculus. It was discovered by Wollaston in 1797, but the nature of oxalic acid deposit was long afterwards originally investigated by Dr. Golding Bird. The colour is rich mahogany brown, or sometimes blackish-green; the shape spheroidal, and surface tuberculated, angular, or even spinous, rarely perfectly smooth; and varying in size from a marble to a horse-chestnut. This remarkable colour and external appearance have given the special name "mulberry" to the oxalate of lime calculus. Its density and weight are great; and section presents an imperfectly laminated structure of irregular waved lines, often resembling knotted heart of oak; occasionally, a notably radiated appearance, like a series of minute needles placed side by side. The fracture is crystalline. Dr. Lionel Beale has specially traced the formation of this calculus, from an oxalate of lime concretion not larger than $\frac{1}{500}$ of an inch; and he finds that dumb-bell crystals are first aggregated together into a small collection, in the interstices of which crystalline matter is deposited, forming a microscopic calculus.

Varieties of appearance are produced by the deposition of crystallized oxalate of lime on the surface of the calculus; sometimes as a coating of transparent octahedrons, or it may be opaque; and the calculus looks as if studded with pearl-spar. The deposition also of amorphous matter, as urates or phosphates, may fill up the intervals between the tubercles or spines, and give the whole an ovoid shape. In compound calculi, oxalate of lime deposition has the beautiful appearance of fortification agate.

Rarer *varieties* are occasionally met with. The small, smooth, globular, "hemp-seed" calculus, of a light-brown colour. Also the calculus of a white or brown colour, and crystalline throughout. Lastly, the pure white oxalate of lime calculus. These varieties are generally found in the kidney. *Tests:*—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *after* heating; solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.

(10.) *Phosphate of Ammonia and Magnesia*—or *Triple Phosphate.*—

Discovered by Wollaston in 1797, this calculus is not common. It is of a white or grey colour, irregular shape, and somewhat spiculated; may attain a large size, and has a friable consistence; is imperfectly laminated, and the fracture sometimes crystalline like alabaster. *Tests:*—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives a crystalline precipitate.

(11.) *Phosphate of Lime Calculus*—also discovered by Wollaston in 1727—is rarely found in the bladder uncombined with other salts; and it seldom forms the nucleus of other calculi. It has a pale brown colour; spheroidal form and smooth surface; is usually small, friable, and laminated. This condition of the calculus is of renal origin, and consists of the neutral phosphate of lime. Another condition is of vesical origin, and consists of bone-earth phosphate; it occurs in the shape of irregular masses resembling mortar, or a granular semi-crystalline powder, enveloped in a tenacious mucus. Phosphates form around other calculi, or foreign bodies; but they are scarcely ever succeeded by a deposit of uric acid or urate of ammonia, or of oxalate of lime. *Tests:*—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives an amorphous precipitate.

(12.) *Phosphate of Lime, and Phosphate of Magnesia and Ammonia Calculus—or the Mixed Phosphates—Fusible Calculus.*—Another discovery by Wollaston in 1797, this is the most common of the three phosphatic calculi, and represents rather more than one in twelve of all calculi. The calculus is of a white, grey, or dull yellow colour; generally of a very irregular shape, and moulds itself to the situation where found; sometimes globular or ovoid, sometimes in many pieces and assuming a cubic or tetrahedral form. It may attain a considerable size, and has a very friable consistence and pulverescent character, or a soft consistence, resembling moist chalk. Section shows generally a concentric lamellar structure, and sometimes shining crystals of the triple phosphate between the laminæ, or a semi-crystalline appearance. The relative proportion of the constituent phosphates varies exceedingly, and the predominance of one or the other phosphate gives peculiar characters; an abundance of triple phosphate presents a crystalline texture, while that of phosphate of lime exhibits an amorphous earthy appearance. Mixed phosphates are more commonly deposited on foreign bodies introduced into the bladder; encrusting them with white, friable, calculous masses. *Tests:*—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate; without addition, easily *fusible* before the blowpipe.

(13.) *Silicious Calculus.*—As a separate concretion this calculus has not been met with; but silica has been found in other calculi by Berzelius, Vauquelin, Fourcroy, and Venables. *Tests:*—Silica is negative with regard to all the tests for other concretions; it is *not* acted on by heat, acids, or alkalies.

The relations of *all* these Calculi to *Tests*, as already stated with reference to the several forms of Calculi, and, moreover, the additional

(II.) TABLE FOR EXAMINING URINARY CALCULI.

1. *By Heat.*	2. *By Acids.*	3. *By Alkalies.*	*Nature of the Calculus.*	*Special Tests.*
Destroyed by heat.	With nitric acid, red.	Soluble in carbonate of potash, evolving *no* ammonia.	Uric acid.	Solution in caustic ammonia or potash, on the addition of an excess of acid, crystallizes in angular crystals. Not soluble in water.
		Soluble in carbonate of potash, evolving ammonia.	Urate of ammonia.	Soluble in water, when boiled. Solution in water, with a few drops of ammonia, evaporated, crystallizes in needles—microscopic.
	With nitric acid, not red.	Soluble in ammonia, *not* crystallizing when evaporated.	Uric or xanthic oxide.	Insoluble in carbonate of potash; dissolves without effervescing in nitric acid, leaving a lemon-coloured residue; soluble in strong sulphuric acid, not precipitated by dilution.
		Soluble in ammonia, crystallizing when evaporated.	Cystic oxide or cystine.	Soluble in strong caustic potash; the solution, boiled for a few moments, on the addition of a drop of dilute acetate of lead, gives sulphuret of lead.
		Soluble in ammonia with difficulty, not crystallizing.	Fibrin.	With nitric acid becomes directly yellow. Solution in caustic potash precipitable by acetic acid in amorphous form.
Not destroyed by heat.	With hydrochloric acid soluble; *before* heating effervesces.	Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.	Carbonate of lime.	Soluble in dilute acetic acid, with effervescence.
	With hydrochloric acid soluble; *after* heating effervesces.	Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.	Oxalate of lime.	Insoluble in acetic acid. Boiled with carbonate of soda, oxalate of soda is dissolved, precipitated by chloride of calcium.
	With hydrochloric acid soluble; does *not* effervesce *before* or *after* heating.	Solution in acid, with excess of ammonia, gives a crystalline precipitate.	Phosphate of ammonia and magnesia.	With half its bulk of phosphate of lime (bone-earth), is very fusible before the blowpipe.
(Not destroyed by heat.)	(With hydrochloric acid soluble; does *not* effervesce *before* or *after* heating.)	Solution in acid, with excess of ammonia, gives an amorphous precipitate.	Phosphate of lime.	With twice its bulk of phosphate of ammonia and magnesia, is very fusible before the blowpipe.
—	—	Solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Mixed phosphates.	Without addition, easily fusible before the blowpipe.
Not acted on.	Not acted on.	Not acted on.	Silica.	Fused with twice its bulk of carbonate of soda, forms glass; soluble in water, precipitable by hydrochloric acid.

tests pertaining to *each*, are conveniently shown in the preceding tabular view of General and Special Tests for Urinary Calculi; which represents also the order of chemical examination. It is enlarged from the well-known lectures of Dr. Bence Jones on Animal Chemistry.

Examination of Urinary Calculi.—The *appliances* requisite for the *examination* of Calculi are few and simple; a platinum spoon or piece of platinum foil, a spirit-lamp, and sometimes the aid of a blowpipe; test-tubes and watch-glasses, with the acids,—nitric and hydrochloric, and the alkalies,—carbonate of potash and oxalate of ammonia. Certain special reagents are noticed in the table.

The *order* of *procedure* is, first to test a bit of the calculus in powder, by *heat*, and thus refer it to one of the two divisions: calculi combustible, and destroyed by heat, leaving only a very little residue; or calculi incombustible, and not destroyed by heat, leaving a considerable residue. In the former case, the original powder is to be tested for uric acid, urate of ammonia, uric oxide, or cystic oxide; in the latter case it is to be tested for carbonate of lime, oxalate of lime, ammoniaco-magnesian, or triple phosphate, phosphate of lime, or mixed phosphates. Next the *mineral acid* test is to be applied; if a combustible calculus, dilute nitric acid should be used; if a non-combustible calculus, dilute hydrochloric acid is preferable. Then, the *alkaline* test must be applied. Lastly, the *special tests* may be resorted to.

Causes of Urinary Calculi.—The urinary formation of calculi has already been adverted to. But certain *predisposing* causes seem to have a tendency to the production of stone.

Climate and Locality have apparently some predisposing influence. Calculus is more common in temperate than in warm and cold regions, and more especially in humid countries of moderate and changeable temperature, such as Holland, France, Germany, and England. It occurs, however, very frequently in Egypt, Isle of France, Russia, Bagdad, and both the East and West Indies. Some parts of the same country are certainly more prone to calculus-production than other parts; as particularly the county of Norfolk in this country. *Race*, it is said, has different proclivities; calculous disorders are more common among white than dark races of men, yet stone is of very frequent occurrence among the natives of India.

The *relative frequency* of different Calculi varies in different countries. Dr. H. V. Carter's observations, on the composition of more than a hundred specimens in the Grant Medical College, Bombay, show the relative frequency of the different urinary constituents, as forming the nucleus and the body of calculi, in India and in England. (1.) That in Bombay, the proportion of calculi having oxalate of lime for their nucleus, or wholly composed of it, is about twice as great as in England; taking for comparison certain standard collections of calculi in this country. (2.) That the proportion of calculi having uric acid or a urate for their nucleus or entire substance, is considerably less in India than in England; in the former country, urate of ammonia calculi are somewhat more frequent than uric acid calculi, and conversely in England. (3.) That the number of calculi wholly composed of earthy phosphates, or having them for a nucleus, is proportionately much fewer in India than in England, owing chiefly to the rarity of the mixed phosphate in the former country.

Hereditary transmission is evinced in the gouty diathesis, and thence the production of lithic acid calculi.

Sex undoubtedly affects the relative proportion; stone is less frequent in females than males, in the ratio of 1 to 20, or 1 to 23. This remarkable disproportion is attributed mainly to the peculiar anatomical disposition of the female urethra; its comparative shortness, larger size, dilatability, and straight course, all these circumstances facilitating the passage of a small stone.

Period of Life or Age.—Stone may occur at any age, and according to Stahl and Geyer, it occasionally exists as an intra-uterine affection. But the two extremes of life seem to be most subject; stone being met with most frequently, it is said, in young and in old people. Of 5376 cases collected by Civiale, 1946 occurred before the age of 10 years, 943 from 10 to 20, 460 from 20 to 30, 330 from 30 to 40, 391 from 40 to 50, 513 from 50 to 60, 577 from 60 to 70, 199 from 70 to 80, and 17 after 80 years of age. Coulson has collected 3264 cases of lithotomy; under 20 years of age, the proportion was 71·20 per cent.; between 21 and 40 years, 12·10 per cent.; between 41 and 60, 10·87 per cent.; and between 61 and 80, 5·72 per cent. Sir H. Thompson's table comprises 1827 cases; under 20 years of age, 60·42 per cent.; between 21 and 40, 10·18 per cent.; between 41 and 60, 17·56 per cent.; and between 61 and 81, 11·83 per cent. Respecting the value of these statistics, Mr. Coulson has well remarked that they represent the absolute number of persons affected with stone, at different ages; but not as relative to the total number of persons living, at the several periods of life. Thus, if all persons under 20 years were affected with a certain disease, and all persons over 70 years were affected with the same disease, the liability would be the same, although the absolute number of persons attacked would be very different. By correcting this error between absolute and relative numbers, the tables would show that children and young persons are less liable to calculous disorders than is commonly supposed; that from 20 years upwards, the tendency goes on increasing in a very remarkable manner to the end of life. Sir H. Thompson thus expresses it: "that the proportion of elderly calculous patients to the existing population at their own ages, is larger than the proportion of children affected is to the number of existing children."

Habits of life have unquestionably some causative tendency. Thus, sedentary habits diminish the perspiratory secretion, and throw increased work on the kidneys; high living and especially indulgence in various kinds of nitrogenized food, and certain beverages, supply the material for uric acid and other allied concretions; while indigestion and secondary mal-assimilation in the textures generate uric acid. All this pathology of Urinary Deposits is fully considered in my treatise on "Diseases of the Bladder," etc.

Various morbid conditions of the *urinary organs* may induce calculous formations; the presence of a foreign body especially, which solicits the precipitation and deposition of the urinary constituents around itself as a nucleus.

Other accredited causes are doubtful. Thus, the imputed influence of certain mineral waters is fallacious, none of the forms of calculi corresponding to the salts in such waters. The alleged exemption of persons in certain occupations, as soldiers and sailors, seems very doubtful.

Diagnosis of Urinary Calculi.—In relation to treatment—whether medical or surgical, and especially the former—the *species* of urinary calculus is a question of great importance.

The elements which, singly or collectively, determine the diagnosis are—examination of gravel or small portions of concretion passed in the urine, the accompanying condition of urine, the constitutional condition or diathesis, and the other predisposing causes already enumerated. If all this knowledge should fail to establish any positive conclusion as to the nature of a calculus, it may at least have a *negative* value, by indicating the species to which the stone is not allied, and thus indirectly guide to an appropriate treatment.

The examination of *gravel*, or small portions of concretion, supplies the most exact knowledge relative to the species of calculus, co-existing.

The condition of *urine* passed at the same period affords the next most reliable ground for diagnosis. Urinary reaction and deposits are here the indications to be observed.

The *reaction* may be acid or alkaline; and the latter from fixed alkali, or from volatile alkali—carbonate of ammonia.

(1.) *Acid* reaction will indicate that the calculus is either uric acid or oxalate of lime, or a combination of both species of concretion. A *deposit* of one or other of these constituents can alone determine the particular species of calculus. Not unfrequently, either deposit alternates with the other, and then a combination of both may be inferred. The presence of either deposit in the urine for any considerable period would indicate that the external crust of the stone is of that kind; but this will fail to indicate the composition of the deeper substance.

Renal calculi contrast with vesical calculi, in being much more simple,—consisting, usually of only one species; while the vesical are usually compound,—consisting of two or more species. This complexity increases often according to the period during which the calculus has remained in the bladder. Consequently, if the calculus originated in the kidney, but has descended into the bladder at a recent date, it will probably be *simple;* and while an acid reaction might indicate either uric acid or oxalate of lime, the deposit will probably determine which species constitutes, in this case, the *entire* calculus.

The relatively greater *frequency* of uric acid compared with oxalate of lime calculus, is a consideration which will aid and corroborate an otherwise doubtful diagnosis; but such evidence is of much less value than that supplied by examination of the urine.

Constitutional predisposition is a more important element in our calculation of probability. Thus, the gouty diathesis will more probably be associated with uric acid than with oxalate of lime calculus.

(2.) *Alkaline* urine has a widely different significance, according to the nature of the alkali. *Fixed* alkali is associated with phosphate of lime, or with carbonate of lime. Both these species of calculi are rare, and the latter extremely so. *Volatile* alkali—carbonate of ammonia, is always associated with a calculus—when present—the crust, at least, of which consists of phosphate of ammonia and magnesia, with phosphate of lime, forming the mixed phosphates or fusible calculus. But the composition of the nucleus and body of the calculus is not indicated, and the thickness of the crust will depend on the greater or less degree of ammoniacal reaction and odour; this, again, will be influenced by the quantity of muco-purulent secretion, as estimated by its discharge in the urine; and the duration of this twofold condition of urine will, of course, affect the resulting proportion of the encrusting deposit. At length, even portions of phosphatic concretion may be passed with the urine. It is necessary to observe that the urine is ammoniacal when passed, and not as the result of decomposition, subsequently.

TREATMENT.—Urinary calculi may be subjected to two kinds of treatment—medical and surgical.

Medical treatment has two objects in view: the *prevention* of the formation of a calculus, when the causative conditions predisposing thereto exist; the *removal* of a calculus by solution, and the expulsion of its constituents through the urethra, or the solvent treatment.

Surgical treatment is restricted to the accomplishment of the latter object—the removal of a calculus, and by means of certain operative and mechanical procedures: *lithotrity*, the removal of a stone mechanically, by crushing it in the bladder with instruments, and extraction or expulsion piecemeal of the *débris* through the urethra, or perhaps by simple dilatation of the urethra without any cutting operation; *lithotomy*, or the extraction of stone by a cutting operation.

The two kinds of treatment are here stated in the order of their relative desirability, but their practicabilty is nearly the reverse, surgical treatment being generally far more effectually curative.

Preventive Treatment.—The prevention of calculous concretion presupposes the recognition of any such signs as may indicate a predisposition thereto, and in due time to anticipate this result. An habitual and persistent *deposit* in the urine of some one or more of the constituents of a calculus, is the surest indication of the probable issue. Thus, persistent deposits of uric acid, urates, oxalates of lime, earthy phosphates, or cystine, as the constituents, severally, of the more common species of urinary calculi, are premonitory of their formation; but only under, or particularly, certain circumstances of urinary deposit. The significant conditions are when the deposit, as of uric acid or oxalate of lime, is found in the urine immediately after micturition, or is deposited before it has cooled. Either appearance would indicate that the constituent of one or the other concretion is secreted with the urine. Whereas, the same appearance taking place at a subsequent period, when the urine has stood for a few hours, might be the result of after-changes. An ammoniacal condition of urine, in connection with cystitis, has always a tendency to concretion of the earthy phosphates deposited. The liability to calculous formation will be obvious whenever any portion of concretion has passed with the urine, or the patient has undergone an operation—lithotrity or lithotomy—for the removal of stone from the bladder.

Preventive treatment may be general, as relating to all calculi, or special, as relating to the different species of stone. The *general* indications are to prevent any concentration of urine, and its prolonged retention in the bladder. Either or both conditions would obviously have a direct causative tendency to the formation of calculous concretion. Concentration of the urine occurs mostly after fasting, some hours previous to the next meal, and during sleep; in the latter physiological state of the system also, the urine is not only scanty, but retained in the bladder for a longer period than in the daytime. And during fasting or sleep—states of the system more or less remote from the process of digestion—the urine becomes highly acid; but again more nearly alkaline after a meal, when a flow of the acid gastric juice into the stomach reduces the acidity of the blood. The recumbent posture, during sleep, was conceived by Dr. Prout to favour the accumulation of urine in the pelvis of the kidney, and thus possibly induce the formation of renal calculus.

To meet all these contingencies, an increased quantity of water or other aqueous fluid should be drank, especially after an interval since food was taken, or at bedtime. The intervals between meals, moreover, should not be protracted, nor sleep in bed unnecessarily prolonged. Thus, a tumbler of water may be taken once or twice daily; particularly before a late dinner, and on going to bed; while instead, perhaps, of only two meals a day—breakfast and dinner—luncheon should also be taken, at nearly equal intervals, and early rising should be enjoined. The latter precaution will be of less consequence if the individual be accustomed to wake once or twice in the night, when the bladder can be relieved of its contents.

Special Preventive Measures.—Predisposition to the formation of *uric acid* calculus may be controlled by the medicinal and dietetic measures already noticed in relation to the precipitation of this acid as a urinary deposit. Alkalies, such as the bicarbonate, acetate, or citrate of potash, in drachm doses to a tumbler of water, as a diluent, should be taken morning and evening. Vichy water or lithia water may be drank in preference. A reduced proportion of animal or azotized food, and more active exercise to carry off any excess, will also have a preventive tendency. Free perspiration, to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Hence, warm clothing, warm bathing, friction of the skin by the daily morning use of Turkish towels or horse-hair gloves and belt, are most efficacious.

Predisposition to *oxalate of lime* concretion may probably be kept in subjection by the observance of similar precautions. Aqueous drinks, to prevent any supersaturated solution of the oxalate; and the avoidance of those articles of diet which contain, or perhaps generate, oxalic acid—as rhubarb, sorrel, onions, tomato, and sugar, or sugar-forming food. Animal food, with brandy-and-water instead of beer or wine, form a suitable diet; but no hard water should be drank—it should be distilled, to deprive it of lime. Otherwise, the lime combining with oxalic acid would induce the urinary concretion. Medicinal preventive measures may be either acids or alkalies. The mineral acids, particularly hydrochloric and nitro-muriatic acids, were strongly recommended by Dr. Prout. On the other hand, alkalies might prove serviceable, if uric acid by conversion be the source of the oxalic acid. Both acids and alkalies may be administered alternately, to combat any tendency to an association of the two species of calculous concretion.

The prevention of *phosphatic* concretions relates especially to the *earthy* phosphates—the more common constituents of such calculi. The phosphates of lime and magnesia are deposited in connection with an ammoniacal alkaline state of the urine, as depending on muco-purulent cystitis. Concretion is apt to form around some portion of pus or mucus, or a fragment of any stone left in the bladder after lithotrity or lithotomy. Hence the corrective use of acids is indicated, and particularly by injection into the bladder, as in the treatment of chronic cystitis.

No special preventive treatment is required for *cystine* concretion, which is comparatively rare, and any tendency to which will be counteracted by the measures appropriate for uric acid calculus.

Solvent Treatment.—The removal of a calculus by *solution* is a mode of *cure*, which has been attempted by either of two kinds of agents: by chemical solvent agents,—lithontriptics administered by the mouth, or by injection into the bladder; by electrolysis,—the transmission of an electric or galvanic current, for the dissolution of stone in the bladder.

(*a.*) *Chemical* solvent agents comprise alkalies and acids. The former class of remedies may be employed for the removal of calculi which are soluble in alkalies, *i.e.* uric acid, urates, and cystine; the latter class, for those calculi which are soluble in acids, *i.e.* oxalate of lime and phosphatic concretions. The mode of administration of either class of these remedies might be by the mouth, or by injection into the bladder. *Practically*, however, the chemical solubility of urinary calculi, and the mode of attacking them, seems to amount to this: that uric acid calculi only, and allied concretions, are soluble by alkalies, and as administered by the mouth; phosphatic calculi only by acids, and by injection of the acid solution. Oxalate of lime calculi cannot be dissolved by any known solvent agent or method of administration.

It would appear also from Dr. W. Roberts's original series of experiments and clinical observations, that *renal* calculi are more generally amenable to solvent treatment than vesical calculi; of course, necessarily, by the internal method, or passage of the remedy through the kidneys.

The *internal method* is applicable for the solution of *vesical* calculi, according to the observations referred to, only in cases of uric acid calculus, where the stone is not large, and the urine is acid.

Certain rules should be observed in applying this solvent treatment; namely, to keep the urine *continuously* alkaline, and to maintain this state to a certain *degree*. A solution of bicarbonate of potash, less in strength than three grains to the pint of water, will have scarcely any greater effect than simple water.

The acetate and citrate of potash are the best salts for administration. Of the former, the dose for an adult should be from forty to sixty grains, in three or four ounces of water; for children, from twenty to thirty grains. The citrate is best prepared pure and of uniform strength from the crystallized bicarbonate of potash by the crystallized citric acid. Thus, the following prescription, recommended by Dr. Roberts, yields a solution containing one drachm of the citrate in each fluid ounce:—Potass. bicarb., ʒxij.; acid. citric., ʒviij., gr. xxiv.; aquæ, ad ℥xij. The dose for an adult is six to eight drachms, mixed with three or four ounces of water; for children, three to six drachms, diluted in the same proportion.

To fulfil both the rules laid down, the dose must be repeated at intervals of not less than every three hours during the day, taking a dose the last thing before going to bed, and another, if the patient should be awake, in the night.

In conducting the treatment, the freshly voided urine should be frequently examined. If, at any time, it becomes ammoniacal, as denoted by the odour and muco-purulent deposit, the solvent treatment must be suspended. So long as the urine remains free from ammoniacal taint when passed, there will be no risk of any deposition of the mixed phosphates encrusting the stone.

Injection.—The other method of applying solvent agents is restricted chiefly to calculi which are soluble in acids—phosphatic calculi. Alkalies, administered by injection, have very little effect on uric acid calculi; and acids pass through the kidneys only in very small proportions.

The injection method of treatment is, however, somewhat in this dilemma, that the solution, if strong enough to have any useful effect, may endanger the coats of the bladder; and if sufficiently diluted to avoid this danger, any solvent action on the stone is very uncertain.

A weak solution of nitric acid—two or two and a half minims of the strong acid to the ounce of distilled water—was used by Sir B. Brodie, for the solution of phosphatic calculi by injection; and with the result of greatly reducing the size of the stone, or even at length accomplishing its entire dissolution. A weak solution of acetate of lead—one grain to the ounce—with a mere trace of free acid, was the preparation and strength employed by Dr. Hoskins.

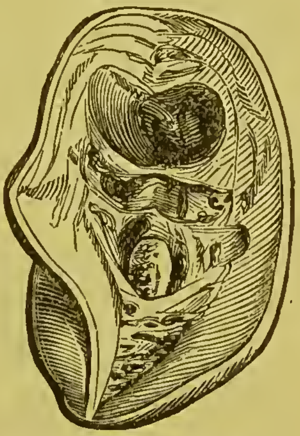
After lithotrity, injection may be used, as a solvent method of treatment adjunctive to, or as a substitute for, the operations of crushing fragments. The comparative merits of these two modes of procedure—the chemical solution, or mechanical crushing of stone in the bladder—must be determined by their relative speed and safety in effecting a cure. Good results have been obtained; notably in a case by Mr. Southam, of Manchester. After repeated lithotrity, fresh phosphatic concretions continued to form in the bladder as fast as the old ones were crushed, so that the bladder could not be cleared. The mechanical operation having thus failed, an injection, containing two drachms of dilute nitric acid to a pint of water, was resorted to every day, or every second day. In the course of a short time, the old fragments were entirely dissolved, and the formation of new concretions prevented.

Injection may be performed through a double-current catheter, whereby a continuous stream of the solvent is made to act upon the stone.

(*b.*) *Electrolysis*, or the dissolution of stone in the bladder by the transmission of an electric or galvanic current, has had its advocates. Sir. W. B. O'Shaughnessy, Dr. Bence Jones, Dr. L. Melicher, and Gruithuisen, have severally attempted this method of treatment.

It will be seen that the foregoing methods of treating urinary calculi apply only to exceptional cases.

FIG. 872.*



RENAL CALCULUS.—A stone forming in the pelvis of the kidney may, or may not, be attended with pain or other symptoms of nephritic irritation. Frequently it remains quiescent and unsuspected when lodged in this dilated portion of the ureter. (Fig. 872.) It may there attain a large size and remarkably irregular shape, being moulded to the pelvis and calices of the ureter within the hilus of the kidney. Absorption of the kidney-substance results from the continued pressure, and this is attended with pain in the lumbar region and symptoms of nephritis. In rare cases, abscess has been known to ensue and the stone be discharged through an aperture in the loin.

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* St. Mary's Hosp. Mus., H. *a.* 23. Calculus in the pelvis of kidney; the stone has the form and size of an acorn, and its surface is beset with hard, spinous projections. Probably oxalate of lime. Patient died of tubercular meningitis, with cavities in both lungs. (Dr. Alderson.)

A *small* stone in the pelvis of the kidney usually descends through the ureter into the bladder; it gradually increases in size, as a vesical calculus, by accumulating concretion on its surface.

The *descent* or passage of a renal calculus is accompanied with more or less severe pain and constitutional disturbance, according to the size and shape of the stone. A small, smooth stone may descend without occasioning any notable suffering. A larger-sized and rough stone, as a mulberry calculus, descends with much difficulty and causes proportionate agony. After perhaps some symptoms of nephritic irritation, the patient is seized with sudden and excruciating pain in the loin, extending down the course of the spermatic cord to the testicle, which is often retracted, and down the thighs. This agony may, as it is said, "double the patient up," and make him roll on the ground, vainly seeking and imploring relief. It is worse to bear, and to witness, than the pain in passing a gall-stone. Bloody urine, vesical irritability, and frequent micturition, with vomiting and constitutional irritation, are the additional symptoms of a descending renal calculus, and which simulate acute nephritis. But the constitutional disturbance is not febrile, the pulse remaining comparatively unaffected. These symptoms continue, with occasional remissions, from generally twelve to twenty-four hours,—the usual period occupied by the descent of a renal calculus; when, on its entering the bladder, all the symptoms suddenly cease. This origin, character, and termination of the symptoms determine the diagnosis. Sometimes, the calculus remains impacted in the ureter, and symptoms of pyelitis supervene. When the stone has become vesical, and is lodged in the bladder, the symptoms of stone in the bladder begin.

Treatment.—Only palliative measures are available. Opium is the most efficacious anodyne for assuaging the nephralgic pain, and the patient can be kept under its influence during the whole period of passing the stone. Chloroform may, however, be administered with advantage, from time to time, as a relaxant. The warm bath is also a most serviceable adjunct. Cupping in the loins, followed by warm fomentations, may afford some relief. The bowels should be thoroughly emptied by mild oleaginous enemata, and diluent drinks freely allowed.

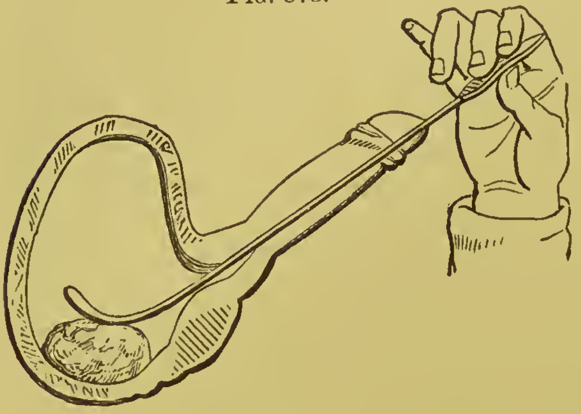
STONE IN THE BLADDER.—*Symptoms.*—A stone, *loose* in the cavity of the bladder, falls into the most dependent part, behind the prostate; but it shifts about according to the varying posture of the patient. The symptoms produced arise from the mechanical irritation and the obstruction caused by the stone as a foreign body in the bladder. They are always essentially the same in kind, though modified in degree in different cases, and may be comprised under four heads: pain, chiefly in the glans penis; irritability of the bladder with increased frequency of micturition; obstruction occasionally to the passage of urine; and morbid conditions of the urine, bloody urine in particular. In addition to these four symptoms, which severally may arise from other causes than stone, there is the physical sign of a hard body elicited by *sounding* the bladder with a metallic instrument, whereby a stone can be felt and heard when struck,—the sensation and sound as of stone being transmitted through a metallic instrument to the hand and ear. This touchstone, as to the presence of a calculus, is conclusive, when available; and it alone is far more diagnostic of stone than all the mere functional symptoms of its presence.

Taking these symptoms in the order mentioned, their respective *characters* must be noticed more particularly. The *pain* is that of a dull weight about the neck of the bladder, and perhaps an uneasy sensation extending to the lower part of the abdomen, the perineum, or thighs, or even to more remote parts, as the knee, heel, foot, or arm; but the pain shoots along the penis and centres in the *glans*. Here the pain is more acute, and it is aggravated *after* each act of micturition, when the stone settles down on the more sensitive trigone vesical of the bladder behind the prostate. In consequence of this pain in the glans penis, children acquire the habit of constantly handling and pulling the prepuce, whereby it becomes conspicuously enlarged and elongated; the recumbent position also is often sought instinctively in passing water, to relieve the recurring attack of suffering. The *vesical irritability* and frequent desire to evacuate the bladder are in like manner aggravated *after* micturition; for as the urine is strained off by an urgent effort, the stone settles down on its sensitive bed. Thence micturition is not unfrequently spasmodic and involuntary. The semen may be ejected at the same time, and sometimes with troublesome priapism; and there is a tendency to prolapsus of the rectum, in consequence of the oft-repeated straining and spasmodic efforts to relieve the bladder. When the bladder is empty, any movement of the body will be more or less communicated to the stone, which rolls about with every change of posture. Personal experience soon restrains the sufferer's movements. Exercise is avoided, and he shuns any sudden or violent exertion; the pain is increased also by any jolting motion, as in jumping, riding, or driving. The *urine*, passing frequently and in small quantities at a time, may flow freely, in a full stream; but it is very liable to *stop abruptly*, owing to the stone being washed forward suddenly against the neck of the bladder, thus closing the urethral orifice. The *character* of the urine changes. It becomes clouded and sometimes loaded with mucous or muco-purulent deposit, which may clear off as the bladder gets reconciled to the presence of a stone. But it is more often and characteristically tinged or streaked with blood, sometimes amounting to vesical hæmorrhage; and this symptom may continue for a long period. *After* micturition or any rough exercise, bloody urine is more apt to occur, from attrition of the stone and interior of the bladder.

Sounding the Bladder.—A *sound* is a solid steel instrument, shaped like a catheter; but with a shorter curve, and having a bulbous extremity and a broad, flat, smooth handle. It should be smaller than a full-sized catheter, this reduction and its shorter curve enabling the instrument to be freely turned about in the bladder; while its somewhat enlarged extremity may aid in detecting the stone, and its expanded handle render the sensation communicated more perceptible to the touch. A proportionately smaller instrument, and with an abrupt curve, will be suitable for children, in whom the bladder is situated higher up in the pelvis than in adults. Sounds of various sizes and curvature will be required in different cases.

Sounding is performed in the following manner:—The bladder containing three or four ounces of urine, or having been distended to that amount by injection with warm water, and the patient lying in the semi-recumbent position, the instrument is warmed conveniently by slipping it up the arm of the operator for a few seconds, then well oiled, and passed gently along the urethra into the bladder. Its cavity is explored—first, along the inferior surface, by raising the handle of the sound and passing its convexity from the neck of the bladder in a sweep backwards (Fig. 873); then, the bladder should be explored laterally, by revolving the handle from side to side between the fingers and thumb; lastly, the instrument should be withdrawn to the neck of the bladder, and the point turned downwards to the depressed space behind the prostate, and then upwards to behind the pubes. The space behind the prostate may sometimes be advantageously tilted forwards by introducing the finger into the rectum; a proceeding chiefly requisite in old persons.

Fig. 873.

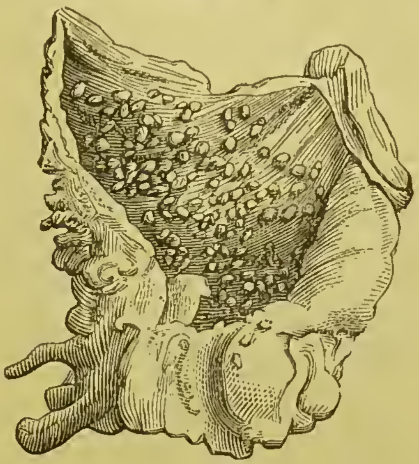


In all these manœuvres, the instrument is used with a gently tapping motion, in order to strike the stone. Failing to discover a stone in the recumbent position, the bladder should be sounded with the patient standing up, and with a more or less than moderately distended state of the cavity. These resources having failed to present the stone, a second exploration may be made in the course of a few days.

The knowledge gained by sounding comprises more than the fact of the presence of a stone. Its *situation* is generally found to be on one side of the neck of the bladder, more frequently to the right; or when small-sized, it usually lies backwards towards the fundus or buried in the space behind the prostate. (See Fig. 873.) Its *size* is less clearly ascertainable; but this may be guessed by observing the extent of hard surface over which the sound passes, and the readiness with which the stone is found in all conditions of the bladder. By introducing a lithotrite, the dimensions of the calculus can be measured in all directions, as indicated by the separation of the blades. The *shape* of the *surface*, whether rough or smooth, is tolerably perceptible to the touch; and the *density* or hardness of the stone can be estimated almost precisely by the sound elicited on percussion with the instrument—by, in fact, *sounding*. A hard calculus, as the oxalate of lime or a uric acid calculus, rings when struck, so as to communicate a click audible to a bystander at perhaps a distance of some yards off; a soft calculus, consisting of phosphates, conveys a dull earthy sound, perhaps scarcely audible to the operator. The grating rough sensation and slight sound of a fasciculated bladder, overlaid with phosphate deposit (Fig. 874), must not be mistaken for a distinct calculus.

A second calculus, or the presence of several calculi (as in figure), can sometimes be distinctly detected by the sound, a stone perhaps lying on each side of the bladder; the introduction of a lithotrite will, however, surely determine the question, when one stone is seized and another struck with the instrument still holding the first in its grasp. Sir H. Thompson has devised and employed a modification of the lithotrite, which acts as a sound, catheter, and measurer. It goes by the name of Weiss's catheter-scoop, with stop-cock.

Fig. 874.*



Sounding is an operation not wholly free from danger. It may induce cystitis and peritonitis, terminating fatally. Sanson, Civiale, Crosse, and others have recorded such fatal cases. Hence, caution and gentleness should be observed in the practice of this familiar procedure. With all possible light-handedness in sounding, severe cystitis is sometimes provoked; as happened in a case where Dr. Gross had sounded a young man who was, however, the subject of stone of twenty years' duration, and accompanied with chronic cystitis.

All the symptoms of stone are more or less *pronounced*, according to the size and shape of the calculus, as a foreign body in the bladder. A large-sized stone is usually attended with more marked symptoms; and an irregular, rough stone is productive of the most severe symptoms. The kind of calculus has some influence, but chiefly as depending on the constitutional diathesis. The quality of the urine will also affect the severity of certain symptoms; a highly acid or alkaline state of the urine having a stimulant action on the interior of the bladder, and thus aggravating the pain and vesical irritability. Lastly, the condition of the bladder itself, when inflamed, whether by irritation of the calculus or its continuance, has a similar influence on these symptoms. Phosphatic calculi imply a previously disorganized state of the bladder or chronic cystitis, and thence the accompanying local and constitutional disturbance of this state. On the other hand, sounding may *fail* to discover the presence of stone, and such instances have occurred in the hands of the most experienced Surgeons; as Cheselden, Pelletan, and Dupuytren. In some cases, *large* calculi, of the size even of a hen's or duck's egg, nearly filling the bladder, have escaped the most careful and minute examination; instances of which are related by Verzascha, Benevoli, Duretus, Riverius, Marcellus Donatus, Chesneau,

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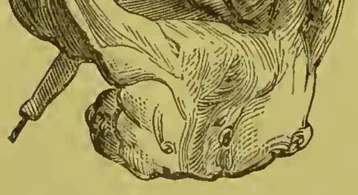
* Roy. Coll. Surg. Mus., 2024. Bladder, showing the mucous coat beset with numerous white calculi, of small size, an angular, irregular shape, and *adherent* in little depressions on the surface of the membrane. At the lower and back part of the bladder these calculi are most closely aggregated, and, with intermediate deposit, form an incrustation. The prostatic urethra is also the seat of several such *adherent* calculi. Others lay loose within the cavity of the bladder. From an old man who had symptoms of stone for a long time before death. (R. Liston.)

Valentin, Riolanus, Morgagni, Covillard, Tolet, Morand, Deschamps, and Chopart, and by Gross as having occurred in the practice of Sir B. Brodie. *Several* calculi cannot always be detected; Collot extracted from the bladder twenty-two previously undiscovered calculi, which were hard and the size of a hazel-nut. Failure has occurred also after *repeated* exploration, as in the hands of Abernethy, who thus failed to discover a large, rough, oval calculus. In some such cases, the stone has remained undiscovered for years, until *after death*. In other cases, and not unfrequently, a stone may be distinctly felt at one time, and not at another; a remarkable instance of which fell to my own lot. I had distinctly touched a small stone, lodged apparently in the cul-de-sac behind the prostate, and it was also felt by other Surgeons; yet, a few days afterwards, when about to operate, I could not detect the stone as the patient lay on the table, nor could it be discovered by Mr. Coulson, sen., or by Mr. Gutteridge; the latter skilled lithotomist having explored the bladder in various states of distension and the patient standing up. In about a month afterwards, the patient came to me with the stone in his hand; he told me that he had been seized with an intolerable desire to pass water, and as if the passage would burst, when the stone suddenly shot out and rolled across the room. Lastly, a calculus may be found *apparently*, by sounding; and then the unhappy mistake has been made of cutting for stone and finding none. This misadventure has, however, happened to the most experienced Surgeons; to Cheselden, who on three occasions cut and found no stone; Crosse also, Roux, and Dupuytren, each of whom have thus performed abortive operations. Velpeau was acquainted with four such instances; S. Cooper knew of seven; and Mr. Coulson can refer to at least seven cases, at two of which he was present, where patients have been subjected to lithotomy, with the absence of any stone in the bladder. (See Gutteridge on "Cutting for Stone and finding none, explained.")

Encysted calculus is so named when the stone is lodged in a cyst or pouch of the mucous membrane, between the muscular fasciculi of the bladder. (Fig. 875.) The symptoms of stone—as caused by a loose, hard body rolling about in the bladder—are necessarily *absent*. There may be some pain and weight, with increased frequency of micturition, arising from the irritation of a foreign body; but there cannot be any aggravation of these symptoms after each act of micturition, and much increased by any jolting exercise—the stone being stationary; nor any sudden stoppage of the stream of urine, and constant liability to the admixture of blood. Then, again, sounding gives less positive evidence as to the presence of a stone. The encysted condition may be suspected, if the stone be struck just once in a way — when its exposed surface is hit by chance, and if it be always found at the same part

FIG. 875.*



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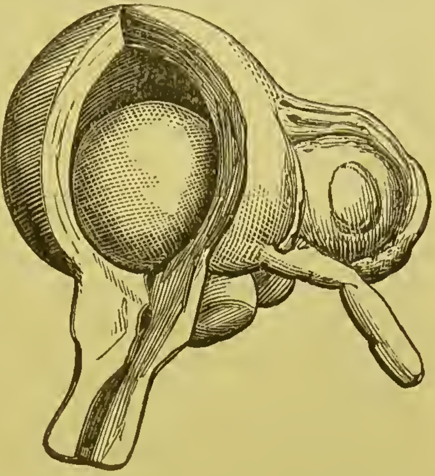
* Roy. Coll. Surg. Mus., 2019. Sacculated bladder; two extrusions of the mucous membrane contain each a calculus, exactly filling the sac, and partly covered by the membrane, without projecting into the bladder. (John Heaviside.)

of the bladder; or if the stone can sometimes be easily felt, and at other times not felt at all, owing to its escape occasionally into the bladder and back again into the cyst. A large encysted calculus, having been struck, may perhaps be defined with the bulb of the instrument; not as an isolated stone, but through the mucous membrane, as a projecting tumour. (Fig. 876.) This comparative absence of symptoms occurs also when a calculus, at first loose in the bladder, *afterwards* becomes encysted.

Fig. 876.*



Diagnosis.—The symptoms of stone, taken severally, may, when *present*, be due to other diseases of the bladder. A pedunculated growth in the bladder is apt, during micturition, to flap over the urethral orifice and thus abruptly arrest the flow of urine. Ulceration of the prostate, or malignant disease of the bladder, both give rise to hæmorrhage. Lastly, the pain and vesical irritability may be sympathetic of an impacted and inflamed testicle within the inguinal canal, in the more rare case of undescended testis. We should therefore not be misled by the presence of any one symptom, but be guided by an *association* of the symptoms in respect to urinary calculus, as in the diagnosis of nearly all other diseases. Even the positive evidence afforded by sounding will often be masked when the prostate is enlarged. And, as Sir B. Brodie first observed, the last-mentioned symptoms, pain and vesical irritability, are often much diminished by this prostatic condition; owing probably to the enlargement protecting the more sensitive neck of the bladder from the weight and friction of the stone. *Difficulties* and sources of fallacy in the way of sounding may be thus enumerated: a large and deformed bladder; a contracted bladder, unable to contain fluid; a sacculated or encysted bladder; an irregular, hour-glass contraction of the bladder, obstructing the passage of the sound into one of the compartments; calcareous matter adherent to the walls of the bladder; calculi in the prostate and urethra; enlarged and roughened prostate; and tumours at the neck of the bladder. The calculus itself may be coated with blood or mucus.

In the *female*, the symptoms of stone are similar to those in the male. Sounding is very easily accomplished, the straight and short urethra readily admitting the instrument and exploration of the bladder. The sound should, therefore, be shorter and less curved. By introducing the fingers into the vagina, the stone can be tilted forward, thus facilitating the examination.

Consequences, and Terminations of Stone in the Bladder.—The bladder, prostate, ureters, and kidneys undergo important structural changes, chiefly of a destructive character. With these changes in the urinary apparatus, exhaustive constitutional disturbance takes place. The *bladder* becoming extremely sensitive, especially behind the prostate, where the calculus commonly rests, the urine is expelled at short intervals, and a contracted state of the bladder results. Sometimes, however, it falls into an atonic and dilated condition, with retention of urine, which by decomposition assumes an ammoniacal and offensive character. In either state, more particularly the latter, chronic cystitis frequently supervenes, subject occasionally to attacks of acute cystitis, with muco-purulent urine. A fasciculated condition of the interior of the bladder usually results, in consequence of an hypertrophied development of the muscular bands beneath the mucous membrane; and not unfrequently between these fasciculi a hernial protrusion of the mucous membrane takes place, forming a pouch or cyst, in which the calculus is apt to lodge as an encysted calculus. An ulcerative and discoloured sloughy state of the mucous membrane sometimes sets in, or a parietal abscess may form, which, opening into the bladder, may receive the stone into its sac, and thus the calculus becomes encysted. Perforation of the bladder has been known to occur, allowing the stone to escape into the peritoneum, or perhaps into the rectum, vagina, or perineum. Pelvic cellulitis sometimes occurs, with diffuse suppuration. These more extreme results have probably been induced by injudicious sounding. The *prostate* usually becomes in some degree enlarged, whereby a depression or pouch forms behind it, as a frequent receptacle for the stone. The *ureters* undergo less marked changes; generally they are somewhat dilated and thickened by chronic inflammation, especially at the pelvic portion adjoining the kidney. This organ is the seat of the most serious and ultimately fatal disorganization. Thus, the *kidneys* may be affected with chronic nephritis; and sometimes, with the acute form of this disease, terminating in suppuration and a speedily fatal issue by uræmia or pyæmia. Degeneration, however, more commonly follows as the consequence of chronic nephritis, and thence death from albuminuria.

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* Roy. Coll. Surg. Mus., 2012A. (Wormald.)

This, the ordinary course of stone in the bladder, extends over a longer or shorter period of years; varying very much according to the kind of calculus, the constitution, and age of the patient. Nevertheless, the course, although more or less slow, and the symptoms more or less severe, is always progressive in its tendency to a fatal issue. As a set-off to this mode of termination, a spontaneous cure now and then happens, by the expulsion of a small stone through the urethra in the act of straining micturition; and, far more rarely, the stone has been ejected by ulceration of the bladder through the rectum, vagina, or perineum.

Operations.—The treatment of Stone in the Bladder consists of the various *operative* procedures appropriate for the removal of Stone. Three methods have been devised, two of which are established Operations: (1) lithotomy, or the extraction of stone by a cutting operation; (2) the removal of stone mechanically by instruments, without a cutting operation—as by lithotrity or crushing in the bladder and extraction or expulsion of the *débris* through the urethra, or sometimes by simple dilatation of the urethra; (3) solution of stone, by chemical agents or "lithontriptics," or by the agency of electricity—"electrolysis." Having regard to the desirability of these several methods of procedure, it might seem proper to notice the latter, or removal by solution, first; but in consideration of the far superior efficacy of the other two methods, they will be described almost exclusively; and first lithotomy, as being the operation perhaps most generally applicable.

Lithotomy, or the operation of cutting for Stone in the Bladder, has been performed in various ways; both as with regard to the seat of operation and the method of its performance. There are three situations in which the bladder may be entered: in the perineum, the supra-pubic or hypogastric region, and through the rectum; thus indicating three principal operations of lithotomy—perineal lithotomy, the supra-pubic or high operation, and the recto-vesical operation. Perineal lithotomy comprises *four* varieties: (1) the ordinary *lateral* operation of Cheselden, and as modified in detail by Key, Liston, and other modern lithotomists; (2) the *median* or Marian operation, revived by Vacca, and as modified by Civiale, Buchanan, and established in modern Surgery by Allerton; (3) the *bilateral* or transverse operation of Dupuytren; (4) the *quadrilateral* section of the prostate by Vidal de Cassis.

No branch of Surgery possesses a history more interesting, curious and romantic, than that of lithotomy, and its comparatively recent substitute—lithotrity; and nowhere is the temptation so alluring to an author in love with his Profession, to trace the gradual development of surgical principles and their application in practice. Nor would such a history be out of place in a work embracing the *Science* conjoined with the Practice of Surgery. But the necessary allotment of space forbids that which would be a somewhat lengthened diversion.

Preparation of the Patient for Lithotomy.—Some Surgeons, as Key and William Coulson, have paid great attention to the state of the patient's constitutional health preparatory to operation; other Surgeons of equal eminence, as Liston, have not deemed it necessary to delay the operation by much preparation. The nervous system being tranquil, or subdued by an occasional opiate, the skin acting freely, and the urinary secretion having been corrected as far as possible by alkalies or acids, according to the character of the calculus, the bowels should be well relieved by mild purgatives, and the rectum especially must be emptied by an enema of castor oil and gruel on the morning of the operation. On no account should the operation be performed until the enema has come away, the loaded state of the bowel much increasing the liability of wounding this part.

Instruments.—Certain arrangements, which although simple, are indispensable to the safe performance of lithotomy. A firm, even operating table, lightly covered with a doubled blanket so as not to present any thickness into which the buttocks might sink unevenly; a piece of waterproof covering being placed over the blanket, of sufficient length to hang down over the end of the table. Pillows are requisite to support the back. A firm stool is the most convenient seat, and it must be of such height, relative to the table, that the patient's buttocks shall be level with the operator's breast when he sits down. This adjustment is easily made by experience. A small low table or a large chair should be provided, on which the instruments are laid out; and placed to the right of the operator, so that he can readily help himself during the operation, independently of any assistant for this purpose. The appliances and instruments requisite are — a pair of bandages of coarse flannel, each about three yards long and two inches in width, or leathern couplets may be preferable; two lithotomy-knives or scalpels, namely, a sharp-pointed, straight-backed knife, and a blunt, button-pointed knife, somewhat curved backwards towards the end; a staff, boldly curved and deeply grooved on its left side, with a good pit at the end of the groove, the size of the instrument being sufficient to fill the urethra, and the handle roughened; lithotomy-forceps, straight and curved; scoops of different sizes; a bladder-searcher; and an injecting syringe, capable of holding about a pint, the nozzle fitting to a catheter. To these might be added a gum-elastic urine-draining tube, with rings at its outer end, whereby it can be fixed in the bladder with perineal tapes, after the operation. This instrument was invariably used by Liston, and subsequently by Sir W. Fergusson, in the earlier portion of his career; it has also been employed by other excellent lithotomists, and, as a Listonian pupil, I naturally followed for a time the example of the great master. But the tube was, I believe, never used by Coulson, nor by other men of large experience, and it has now fallen into general disuse.

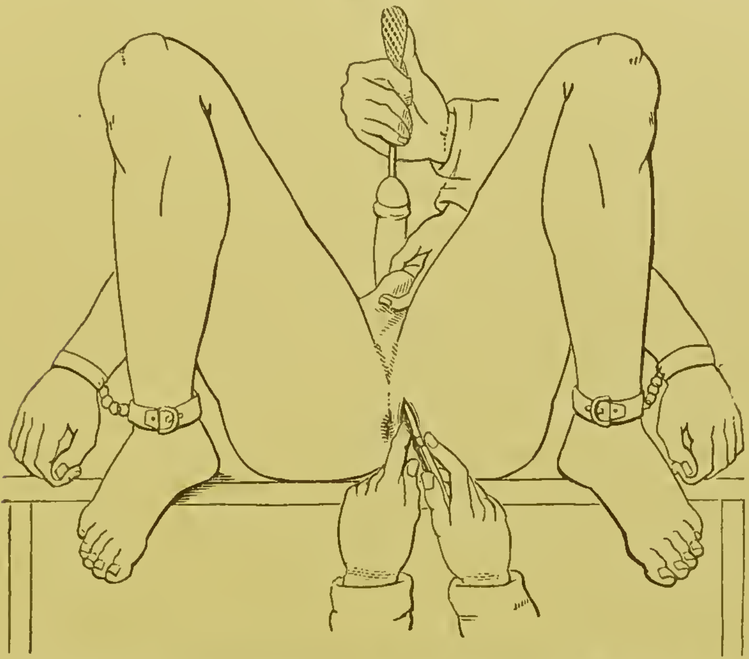
Lateral Operation.—Four assistants at least are required for the performance of this operation; one to administer chloroform, one on each side of the patient to fix the perineum in the proper position as presently described, and a fourth to take charge of the staff. A fifth assistant might be convenient to hand instruments, unless they are placed within easy reach of the operator, when sitting down.

The operation consists in cutting on a staff into the bladder—by a preliminary superficial, perineal incision to reach the instrument, followed by a deep or prostatic incision in the groove of the staff to enter the bladder; and the extraction of the stone. Thence the instruments essentially requisite are simply three: a staff, a knife, and forceps.

The patient is placed recumbent on the table, and chloroform administered. Then the bladder, having been previously emptied of urine, should be injected with tepid water to the amount of about six ounces, in order to steady the bladder and expose the stone to the grasp of the forceps. Sounding should now be performed, immediately before the operation is commenced—when the patient's bladder is in position. This may be done with an ordinary sound; but it is preferable to at once introduce the staff of sufficient size to occupy the urethra, and, using it as a sound, the stone must be distinctly felt and its situation ascertained. This is an imperative rule in regard to lithotomy. If the stone cannot be felt at the time of operating, the operation should be unhesitatingly postponed; if it can be felt, the operation is proceeded with. The patient is brought to the end of the table, so that his buttocks resting on the edge shall project a little beyond it; the legs are to be drawn up and the hands and ankles firmly bound together with the lithotomy bands, as thus,—either hand being placed on the outer side of the ankle and made to grasp the foot, both are securely joined in this position by a figure-of-eight application of the band. Or, the couplet leathern straps used by Sir W. Fergusson is a more simple and equally secure contrivance. Then, the side assistants, taking each a foot in his hand on the inner aspect of the foot, and placing the patient's knee in his axilla, the limbs are drawn sufficiently apart to fully expose and throw out the perineum, at the same time observing that it inclines to neither one side nor the other, but is fixed perpendicularly, or horizontally to the table, and maintained in this position throughout the operation. Unless these two assistants attend only to this, their simply mechanical but important duty,—that of exposing and balancing the perineum, instead of attempting to hang over and see the operation,—they will assuredly disturb the visual line of the operator, and thus embarrass him in his incisions and manipulations.

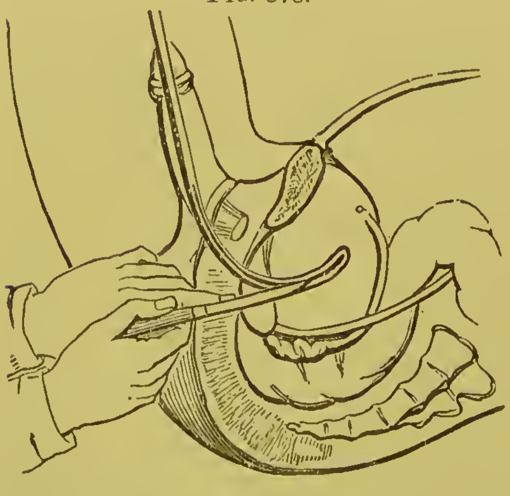
The staff is now given in charge of an assistant, standing on the patient's left, with the injunction to hold it firmly, in the perpendicular direction, and hooked up against the symphysis pubis. (Fig. 877.) I once heard Mr. Coulson request a young assistant to hook up the staff as if to the ceiling; and I thought that illustration as to the mode of holding the staff very suggestive of the right way. Some Surgeons prefer that the convexity of the staff should be made to bulge slightly forward in the perineum; others that it should be turned somewhat towards the left of the perineum; while some prefer that it should be depressed and held in contact with the stone. The assistant holds the staff between the thumb and fingers of his right hand; the left hand is used to raise the scrotum from the raphé running down to the rectum. Thus, then, the space between the urethra and the rectum is exposed as much as possible, so that the one can be more readily approached without the risk of wounding the other.

FIG. 877.



The Surgeon seating himself on the stool in front of the perineum, thus exposed, he shaves the integument on the left side, and introduces his finger into the rectum to know for certain that the bowel is empty and to induce its contraction; whereby any remaining feculent matter will be expelled, and the contracted state of the bowel diminishes the risk of its being wounded during the deeper incision. Then, with his left hand thumbing the tuberosity of the ischium and the ramus on the left side, he feels also, with the point of the forefinger, the sort of depression below the bulb of the urethra, in the middle line or raphé, which lies over the curve of the staff; a point about an inch and a half in front of the anus, rather lower than higher, and corresponding to a part of the instrument which in a thin perineum can often be plainly felt. The landmarks of his incision having thus been clearly defined, the Surgeon rests his left hand on the right half of the perineum, so as to make the skin on the left side slightly tense; and indicating with the forefinger the above spot, he plants the lithotomy-knife in the raphé, or just to the left of it, and carrying the blade in a straight line obliquely downwards and outwards, midway between the anus and tuberosity of the ischium, or somewhat nearer to the latter, terminates the incision at a point just below the anus. A *free* but superficial *perineal* incision is thus made. (See Fig. 877.) The length of this incision will be from three inches to three and a half, in the adult; its extent varying according to the size of the perineum, and apparent size of the stone. The skin, superficial fascia, and fat are divided; but the depth of the incision, varying according to the perineal obesity, is above rather less than an inch, while below the knife sinks a little more deeply into the ischio-rectal fossa. The upper half of this incision, above the anus, leads to the staff; the lower half, by the side of the anus and below it, facilitates the extraction of the stone. The point of the forefinger of the left hand is now drawn firmly, from the upper angle, along the bottom of the wound, between the left erector penis and accelerator urinæ muscle overlying the bulb of the urethra, so as to separate these parts; then, using the finger to protect the rectum, by pressing it somewhat downwards and to the right, any further resisting structures are divided by a slight touch or two with the knife—as in figure. Thus are divided the transversalis perinæi muscle and artery, and the base of the deep perineal fascia or triangular ligament of the urethra, which latter sometimes, in elderly persons, presents a tolerably firm bar to the finger. The finger is then directed upwards from the rectum, as a guide to the staff; the groove of the staff is felt just in front of the prostate, in the membranous portion of the urethra, and as covered therefore with this membranous structure stretching across the groove. By a little compression at this spot, the nail of the finger is lodged fairly in the groove; and then the point of the knife, with the cutting edge downwards, is slid along the finger *over* the nail, and, penetrating the membranous urethra, is at once inserted into the groove of the staff, and felt to touch the metal, the contact with which may be further assured by a slight movement of the point. This relative position of the finger to the knife will securely protect the rectum—itself also pressed downwards and to the right; and which, from its proximity beneath the prostate, is especially liable to be wounded at this part of the operation—the commencement of the *deep* or *prostatic* incision. The knife is now pushed firmly along the groove of the staff, through the prostatic portion of the urethra and the prostate, with a slight inclination of the blade downwards and outwards (Fig. 878); thereby incising or notching the prostate *laterally*,

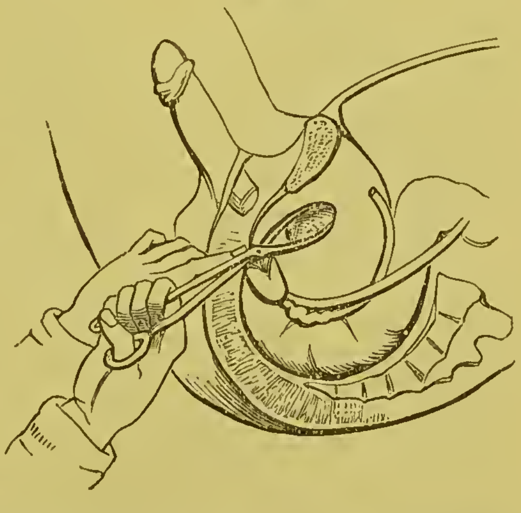
FIG. 878.



in the same direction as the external or superficial incision; while the point of the blade, by slightly depressing the handle to a very limited angle with the staff, follows the curve of the staff, until the bladder is entered. If the knife, directed sideways, runs firmly in the groove of the staff, so as not to slip out to the left, the blade cannot go wrong, and the incision must be right. The bladder is known to be entered by resistance ceasing, and perhaps a gush of water taking place. This incision may be made rapidly and boldly by a practised lithotomist; I have seen Liston run the knife along the groove right into its terminal pit, which the point of the blade might be heard to strike, even turning the point of the instrument. A less-practised lithotomist must make the incision more slowly and cautiously. A *button-pointed* lithotomy-knife may, perhaps, be used more safely, as it locks into, and has a more secure hold in, the groove of the staff. Such a knife was always employed by Coulson. It is introduced into the groove of the staff, after a small incision, to the extent of three or four lines, has been made into the membranous urethra by the sharp-pointed knife, in the perineal incision. I have never yet thought it necessary to use this instrument. In withdrawing the knife through the prostate, it should pass over the finger, in the same direction as in introducing it, and still in the groove of the staff, so as not to enlarge the incision.

This, the deep or prostatic incision, is therefore essentially *limited* in its *extent* through the *prostate;* not exceeding twice the width of the blade of the knife, and certainly not passing beyond the base of the gland, where its *capsule* prevents infiltration of urine into the cellular texture of the pelvic cavity behind the prostate. This precaution is especially characteristic of the Listonian operation. On withdrawing the knife, the left forefinger is pushed forward after it through the prostatic incision into the bladder; and, if this manœuvre be executed adroitly, the introduction of the one follows the exit of the other,—the finger replacing the knife *before* the water escapes in any gush from the bladder. The finger, fitting into the incision, is made to enlarge the wound by a sort of twisting, or tunnelling motion; whereby the opening is dilated and the prostate somewhat split, as with a blunt gorget, instead of having been cut freely by the knife. As the finger proceeds, at the same time the stone is felt for. This double duty of the finger, as a dilator and a searcher, may be conveniently performed while the Surgeon is taking the forceps with his other hand from an assistant, or from a basin of warm water at his side. Having entered the bladder, and found the stone, the assistant is directed to withdraw the staff. Then the Surgeon introducing the closed blades of the forceps over the finger, he slides them into the bladder, withdrawing the finger at the same time, and opening the

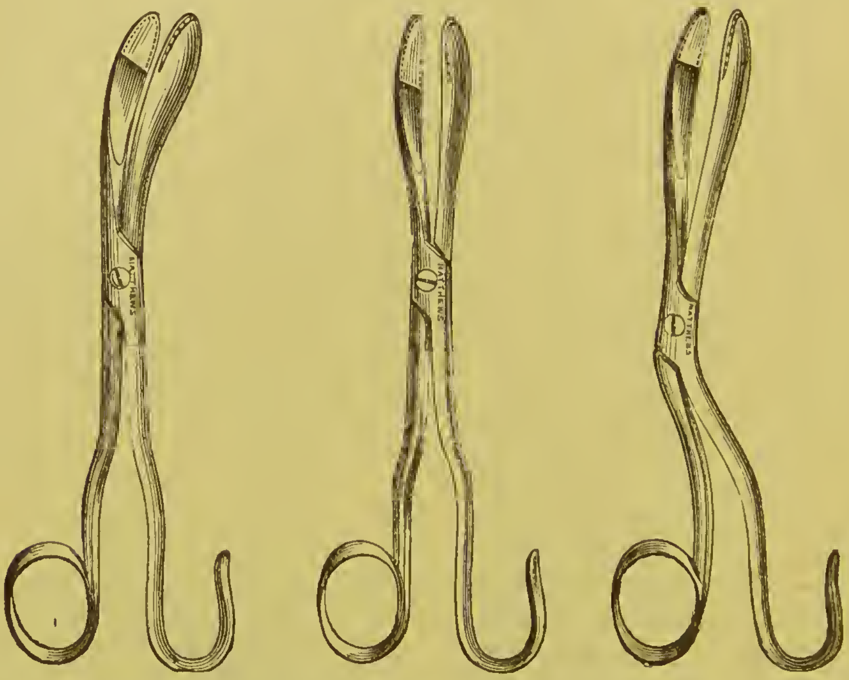
Fig. 879.



blades of the instrument; a gush of water now takes place,—if not previously, in making the prostatic incision,—and thus the stone may sometimes be washed into the grasp of the forceps (Fig. 879); or, on somewhat dipping the forceps, usually with a sort of sweep from left to right across the fundus of the bladder, the stone is at once caught and seized, whereby the instrument feels suddenly locked. Failing, in either of these ways to catch the stone, it should be gently sought for, and touched with the forceps. It may then be seized by one of two manœuvres, as in lithotrity; either by depressing the fundus of the bladder with one blade, and giving a slight shake, when the stone will fall into the grasp of the instrument; or, by sliding the blades along the side of the stone, then opening them, and turning the opened blades over to that body, it will be seized almost with certainty. The size of the stone may be estimated by observing how far the handles are separated. If it seem to be seized in its long diameter, and too large for extraction, the stone may be shifted by a jerk of the forceps, or disengaged and reseized, so as to be extracted without lacerating or bruising the neck of the bladder.

For seizing and extracting the stone, various shaped forceps are sometimes useful; those constructed by Messrs. Matthews, for Sir W. Fergusson, are here represented (Fig. 880); the angular instruments being adapted for keeping the operator's hand out of the line of incision, in the act of extraction.

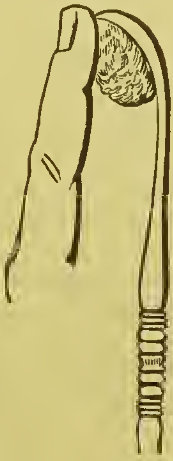
Fig. 880.



Extraction should be performed slowly, and by working the instrument gently backwards and forwards to gradually dilate the prostatic aperture; bearing downwards also in the direction of the axis of the pelvis (see Fig. 879), in order that the widest part of the arch of the pubes may be available for the extraction, and the lower part of the perineal incision which facilitates this concluding part of the operation. The forceps lie in the axis of the pelvis, and are withdrawn in the same direction as obstetric forceps. If, as a rare mishap, the stone slips from the forceps, after having been withdrawn through the prostate, it cannot be reseized under the pubic arch, or without disturbing the cellular connections of the bladder and rectum; the finger should be passed into the bowel, to fix the stone from behind, and then, with the scoop, it may be drawn or tilted out of the wound. After removing the stone, the finger should be reintroduced into the bladder to search for any other stone which may be present; or the *searcher* can be used for this purpose to reach parts of the bladder not readily accessible to the finger, as in front above the pubes. And as, *in* the act of withdrawing the knife through the prostatic incision, the finger at once followed it forward; so also, *in* withdrawing the forceps, the finger is again made to follow this instrument, that thus the entrance to the bladder shall never be lost—an injunction the more imperative when the staff, as a guide, has been withdrawn. No second stone having been discovered, the operation is completed.

Fracture of the stone sometimes occurs, in seizing or in extracting it; and generally as the result of undue force in using the forceps, aided perhaps by the brittle character of the stone, as when the calculus is phosphatic. This accident should be carefully avoided; for the fragments are apt to injure the bladder in any attempt to extract them, and it necessitates the repeated introduction of an instrument. The fragments are best removed by means of the *scoop*, with the forefinger resting on the end of this instrument, to keep the fragment from slipping out of the bowl. (Fig. 881.) The bladder should then be thoroughly washed out with tepid water, injected by a strong brass syringe through a tube introduced by the wound. Several small calculi are most readily removed in like manner—by the scoop.

Fig. 881.



A gum-elastic tube may then be introduced through the wound into the bladder, and retained in position by perineal tapes. This instrument was formerly deemed serviceable for two purposes—as a means of arresting any oozing hæmorrhage, and for keeping the wound free of coagula; thus, by affording a clear passage, to prevent the infiltration of urine. But the latter risk is surely avoided by the limited prostatic incision; and the former advantage is more than counterbalanced in *most* cases, even although such hæmorrhage prove troublesome, by the incessant concentration of the patient's attention to his bladder. The tube is now generally disused in this country.

I have thus described the lateral operation of lithotomy as consisting of three steps—two of which are incisions—a superficial or perineal, including a deeper touch or two with the knife, and the deep or prostatic incision; and then, seizure and extraction of the stone from the bladder. It should, however, be observed by the Student, that although these steps are described separately, they are performed successively as one continuous operation. The procedure consists in an *alternate* application of the left forefinger and the knife, or the forceps. Commencing with the indication of the point for entering the knife in the perineum, this is followed by the superficial perineal incision; then the finger is used successively as a protector, guide, blunt gorget, and searcher, in the manner already explained, with relation to the use of the knife in the perineal wound, the groove of the staff in the membranous urethra, the prostatic urethra and bladder; followed by the forceps, used alternately with the finger in the bladder. The textures are divided downwards and outwards, away from the rectum, by *lateralized* incisions; and they together form an oblique *conoidal* wound, having its base externally in the perineum, and the apex in the prostate. In the *limited* extent of the *prostatic* incision, the operation differs essentially from that of the earlier lithotomists, —Frère Jacques, Cheselden, Desault, or as performed by Klein, John Bell, Martineau, Come, Souberbielle, Langenbeck, Gutteridge, and other most successful operators, all of whom made, or still practise, a free prostatic incision, extending even through the neck of the bladder; but the limited incision has been strenuously advocated by Pierre Franco, Le Cat, Scarpa, Dupuytren, Callisen, Sir A. Cooper, Sir B. Brodie, Crosse of Norwich, Key, Stanley, Coulson, Syme, Sir W. Fergusson, Spence, and by the most experienced modern lithotomists in this country, supported by Dr. Gross, and other eminent American Surgeons.

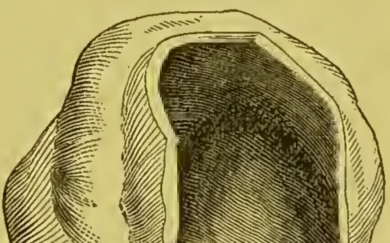
Position of the Hand and Knife.—Much difference of opinion has been held in surgical works of authority, and different delineations have been given, as to the manner of holding the knife in lateral lithotomy. I specially allude to this question on that account alone, and not because of its intrinsic importance. So long as the proper incisions are observed, both with regard to their situation, direction, and extent, it can be of little consequence how the knife is held in executing them. The Surgeon will best accomplish the object he has in view in the manner most convenient to the movement of his own hand; a matter of personal experience, which must necessarily vary with the shape and mobility of this member in different operators. In making the superficial or perineal incision, the knife is generally held *under* the hand; and in making the deep or prostatic incision, this position is still maintained by most lithotomists. Liston, however, would appear to have held the knife *above* the hand in making the latter incision, as depicted in Fig. 878; a representation of the position of the hands and knife, at the commencement of the second incision, (or *through* the prostate—Author), as shown "in a very correct sketch of the viscera of the pelvis, with their relative size and position; and which has been copied more than once without acknowledgment" (Fourth Edition, 1846, p. 509). But, notwithstanding this record by Mr. Liston on the point in question, as an old Hospital pupil, having enjoyed unusual and repeated opportunities of witnessing the operations of the great lithotomist, I can corroborate the statements of Sir W. Fergusson, and Mr. Cadge, of Norwich, that Mr. Liston held the knife *under*hand; and I particularly well remember also that, in entering the point of the knife into the groove of the staff, his fingers were enclosed around the blade, apparently to cover the edge, and fit the point into the groove securely—the instrument being then sent forward from the palm of the hand.

Cutting on a Straight Staff.—This mode of performing the lateral operation was originated by Aston Key, at Guy's Hospital, where it is still practised, and by other Surgeons. The curved staff, as a director for the knife, is ill adapted in its form to guide the point with safety, just where the use of the instrument becomes requisite, in making the prostatic incision. This disadvantage may be overcome by cutting on a straight staff; and the advantage is also gained, that the groove, which had been directed downwards for entering the knife, can now be turned in any oblique line for division of the prostate. But the straight staff is more liable to be tilted out of the bladder than the curved one, and therefore the end of the staff should always rest upon the stone in performing the operation with this instrument.

Having reached the staff by the perineal incision, which has to be carried deeper than to reach the curve of the ordinary staff, the point of the knife is entered into the groove; then the Surgeon, withdrawing the left forefinger from the wound, takes the staff from the assistant previously in charge, and depressing the handle brings it down parallel with the axis of the pelvis, so as to present a direct passage to the bladder. In doing either of these acts, special care must be taken lest the knife slip out of the groove. Feeling certain that it still remains in, the Surgeon lateralizes both staff and knife, in contact, to the left of the perineum, corresponding to the external incision, and pushes the knife onwards along the groove into the bladder; withdrawing it in the same direction, so as to incise the prostate only to a limited extent. Here again, in this nearly parallel mode of using the staff and knife, special caution must be taken lest the point be tilted out of the groove by the front of the prostate; when, instead of entering the bladder, it would pass down into the pelvic cavity. This may be obviated by depressing the handle of the knife to a *limited* angle with the staff, so as not to incise the prostate too far back. Then, having entered the bladder and withdrawn the knife, this instrument is laid aside; the staff is now transferred to the right hand, and the left forefinger, introduced into the wound, is guided by the staff into the bladder and to the stone. The finger resting on the stone, the staff may be withdrawn; the forceps is introduced along the finger, and the operation completed.

Parts cut, and Parts to be avoided, in Lateral Lithotomy.—If the operation be conducted on the principles laid down, the question of the "parts" concerned is more an anatomical investigation than a surgical consideration—more a Student's question than of practical consequence. The parts necessarily *divided*, in their order from without inwards, are—the skin, superficial fascia, and fat, with the inferior hæmorrhoidal vessels and nerves passing across the ischio-rectal fossa; the transverse perineal muscle and artery, with probably the superficial perineal artery and nerves; the base of the triangular ligament and the deep transverse urethral muscle; the membranous urethra and constrictor muscle; the prostatic urethra, and the prostate to a limited extent in its left lateral lobe (Fig. 882),

Fig. 882.



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* Roy. Coll. Surg. Mus., 2038. Bladder and prostate gland, after two operations of lateral lithotomy. The prostate shows two deep grooves—the remains of the incisions, and one of which extends backwards through the *neck* of the bladder. The neck and prostatic urethra are both *greatly dilated*. The patient, fifty-eight years old, had symptoms of stone for a long time, and of renal disease for twenty years. He died two years after the second operation. (Liston.)

including the "ligamentous ring or band" around the neck of the bladder, but not the capsular boundary formed by the reflection of the recto-vesical portion of the pelvic fascia. External to the capsule, some of the anterior fibres of the levator ani muscle will be divided, and within the capsule, a plexus of rather large-sized veins must be severed—in the prostatic incision.

The parts to be *avoided* in the operation are in anatomical works thus enumerated:—the rectum; the internal pudic artery, where it courses forwards under cover of the ramus of the pubes; the bulb of the urethra; and the artery of the bulb, which normally passes inwards transversely about half an inch above the base of the triangular ligament, between it and the other or deep layer of the perineal fascia. Of these parts, the rectum will be avoided by having the staff well hooked up, protecting the bowel with the finger, and lateralizing the knife parallel with the bowel—particularly in an old person, whose rectum is commonly dilated into a pouch just above the anus, sometimes even wrapping around the prostate from side to side. The precaution of emptying the bowel should also be observed. The arterial vessels mentioned are less readily wounded; but, when presenting anomalies, they may be unavoidable. The pudic artery will be avoided by not turning the knife too much outwards in making the deep incision. Posteriorly, this artery is securely lodged under cover of the tuber ischii; but occasionally it descends over the inferior surface of the bladder and across the prostate to reach the penis. Or, the accessory pubic, as an occasional substitute for the pudic, when defective, lies on the posterior edge of the prostate; it may then be avoided by not extending the prostatic incision backwards to the base of the gland. The artery of the bulb, a serious source of hæmorrhage, may perhaps be avoided by not cutting too freely upwards towards the groove of the staff; but an irregular course of the vessel, lower down than usual, cannot be foreseen or avoided by any plan of incision. Sometimes also, as arising from the obturator artery, or as a branch from the artery of the bulb on the opposite side, neither of these anomalies can possibly be anticipated. Lastly, the bulb of the urethra, a source of venous hæmorrhage, may be avoided by directing the point of the knife obliquely upwards beneath its projection, in the act of penetrating the membranous urethra. But I agree with Mr. Skey in not attaching much importance to a wound of the bulb; and I have no doubt it not unfrequently happens without any evil consequence. The venous plexuses, within the capsule of the prostate, are sometimes much enlarged, especially in old men, and become a source of unavoidable hæmorrhage.

As compared with these anatomical peculiarities, it will be found that while anatomy plans the landmarks and limits of the incisions—perineal and prostatic—the *pathological* conditions of the prostate and of the bladder are of more surgical importance in completing the operation.

The Lateral Operation in Children.—Lateral lithotomy is performed in the same way in Children as in Adults; but the anatomical condition of the parts under the age of puberty, and especially in childhood, affects the performance of this operation. The anatomical peculiarities alluded to are chiefly four: looseness of the perineal cellular texture in the recto-vesical space; the small size, thinness, and weakness of the membranous urethra; the rudimentary small size of the prostate; and the position of the bladder—it being situated higher up, or more in the abdomen than in the pelvis. These conditions severally affect the operation in its first part—that of entering the bladder; extraction of the stone is not attended with any special difficulty.

Thus, the superficial perineal incision having been made correctly, the *loose cellular texture* easily yields and gives way under the finger, forming a distinct, smooth-walled cavity or false bladder, in the recto-vesical space; which resembles the interior of the bladder. A very little groping with the finger, in the wrong direction—*downwards*—will form this deceptive cavity; into which the finger readily enters as if into the bladder. Perhaps also the membranous urethra has been penetrated, whereby the urine dribbles away and the bladder gradually collapses; both circumstances apparently confirming the belief that the finger is really in that cavity. Indeed, the latter condition affords more room for the easy enlargement of the false bladder. In this anxious and perilous moment, two points of distinction should be remembered: this false bladder presents *no neck* through which the finger should pass to gain admission, nor can the *bare* grooved staff be felt along the back of the finger when introduced into the cavity. Besides both these negative features of distinction, *above* this cavity, near the symphysis pubis, lies the staff leading to the bladder; and which can be plainly felt on directing the finger from the scene of mischief obliquely upwards to that spot. Hence, the practical inferences are these: in approaching the staff, to avoid making anatomy by a too free use of the finger as a guide; and to direct both it and the knife upwards to the more highly situated staff, instead of heedlessly slipping into and working in the interval between the bladder and rectum. A precaution before operating should also be observed—that of sufficiently distending the bladder with water, to lower its position in the pelvis and to steady its neck. The same kind of misadventure may occur between the neck of the bladder and the pubes, by misuse and misdirection of the finger *upwards*. It need scarcely be added that, in either such case, the little patient remains unrelieved, and dies with the stone in the bladder. Yet this calamity has happened to some of the most skilful and experienced lithotomists—past and present.

Again, in endeavouring to hit the membranous urethra and lodge the point of the knife in the groove of the staff, the urethra being of *small size*, it may be so cut about as to be nearly severed from the prostate. Or, if the point of the finger be not insinuated well into the opening, or if any undue force be used in passing it into the bladder, the *thin* membranous urethra may be torn across, and the neck of the bladder driven backwards on, or off, the staff,—an accident more likely to happen when the urethra has been nearly severed.

Thus then, in opening the urethra, as in approaching it, *fiddling* with the knife must be avoided; and in both procedures, any *forcible* use of the finger will also be mischievous.

The *rudimentary size* of the prostate, and the *high position* of the bladder, will both necessitate a more upward direction of the point of the knife, in making the prostatic incision. And it should be remembered that this incision must necessarily almost always, if not invariably, extend through the whole of the small prostate, in its left lobe; yet without any evil consequence.

In entering the neck of the bladder, the feeling is that of passing over a small ring; without riding over the sort of chestnut-like projection upwards of the prostate, and which may be like a half-orange in an elderly man.

When the prostate has been detached from the membranous urethra, and the neck of the bladder recedes before the point of the finger, all the presence of mind and dexterity of the Surgeon will be required at this trying moment of peril and anxiety. Much will depend on whether the staff still remains in the bladder, as a guide. If so, the forefinger should be passed most cautiously and gently along the groove, and a slight hooking movement made at the neck, so as to draw down this part. It may then be notched, by insinuating the knife along the finger, which can thus be fairly entered. If the staff be out of the bladder, or has been withdrawn, the position of both patient and Surgeon is most critical. It may be possible to reintroduce the instrument, and then proceed as just directed. Failing to accomplish the first step, the attempt to hook down the neck of the bladder should never be resorted to—in the absence of a *guide*. The finger or any searching instrument will only pass deeper and deeper with increasing damage, and inevitable death result. Moral courage is here the better part of valour, and any further operative interference should be resolutely abandoned. The urethra may heal, restoring the continuity of the canal, when the operation can be repeated and brought to a happy issue.

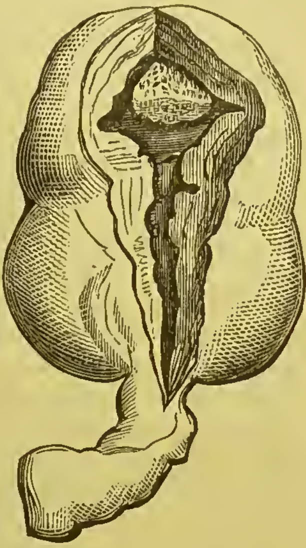
DIFFICULTIES, AND ACCIDENTS, DURING LITHOTOMY.—The *Difficulties* which may occur in the performance of the lateral operation relate either: (1) to entering the bladder; or (2) to seizing and extracting the stone. The first occur more especially in operating on children, and have been already described; the second kind of difficulties are met with more commonly in adults. In *children*, two difficulties are very liable to happen in endeavouring to enter the bladder: the formation of a false bladder in the recto-vesical space, and the incised or torn detachment of the neck of the bladder from the membranous urethra. In *adults*, the first of these difficulties has occurred as the result of prolonged *boring* with the finger in the cellular interval between the bladder and rectum.

(1.) A *deep perineum* presents obstacles to *entering* the bladder. The depth of perineum may be due to fat in a corpulent person, or to an enlarged prostate in an elderly person. Both conditions not unfrequently coexist, coupled also with an indurated state of the prostate. A forefinger of average length can perhaps scarcely reach the bladder, if at all; and the prostatic condition of enlargement and rigidity obstructs the introduction of the finger. The blunt gorget, formerly in ordinary use, is here very appropriate; as affording the means of dilating the incomplete incision in the enlarged and indurated gland, and of gaining access to the bladder beyond reach of the finger.

(2.) *Seizure* and *extraction* of the stone may present difficulties dependent on several conditions:—depth of the perineum, particularly when due to an Enlarged Prostate; an Encysted, or an adherent state of the stone; the Position, Size, and Shape of the stone; Rickety deformity of the pelvis, in its antero-posterior diameter, or by narrowing of the pubic arch. These various conditions interfere with the use of the forceps, either in introducing the instrument into the bladder, or in seizing or in extracting the stone.

Enlargement of the Prostate, which places the bladder beyond reach of the finger (Fig. 883), renders the introduction of the forceps difficult, and seizure of the stone more so, owing to the liability of its falling into the depression behind the prostate, and thus escaping the sweep of the forceps; but the latter difficulty may be overcome by using long curved forceps, at the same time endeavouring to raise the stone by passing the finger into the rectum, if the fundus of the bladder can be reached behind the enlarged prostate. In extracting the stone through an enlarged prostate, some difficulty may be experienced; and rather than bruise or lacerate the parts, it would be proper to incise the opposite side of the prostate towards the tuberosity of the right ischium, thus forming a bilateral section of this body, without making any additional perineal incision. Occasionally, in dilating the prostate, a myomatous or prostatic glandular tumour has been enucleated; and this condition, which Professor Gross has met with in several operations, is said to delay the closure of the wound.

Fig. 883.*



Encysted calculus is not very common; but if this condition be found in exploring the bladder with the finger, the course to be taken by the Surgeon should depend entirely on the size of the aperture of the sacculus. A small aperture will preclude the possibility of removing the stone without endangering life. A large opening, or a partially encysted condition, may allow the stone to be liberated. This can sometimes be effected by a fortunate catch with the forceps; in one case, by Collot, changing the position of the patient proved successful in dislodging the stone; in another, by Sir B. Brodie, the orifice was enlarged with a probe-pointed bistoury, and the calculus turned out with the finger or scoop. The latter procedure is, obviously, extremely hazardous, since the bladder might easily be cut through into the peritoneal cavity. When, therefore, the calculus cannot be otherwise removed, and with tolerable facility, the operation should, as Coulson observes, be abandoned. An *encapsuled* calculus was once found, by Mr. Erichsen, in a child; the stone, about the size of a pea, being felt at the inferior fundus of the bladder, covered in by a kind of false membrane. This membrane was scraped through with the nail, and the stone removed with a scoop. The cyst attached was about the thickness of ordinary writing-paper, of a reddish colour, consisting of organized fibro-cellular tissue, and resembled mucous membrane. Excepting a slight attack of secondary hæmorrhage on the eighth day after operation, the patient made a good recovery. Sir A. Cooper removed an encysted calculus, in the case of a child, without opening the bladder in the usual manner. Passing his finger into the rectum, the stone was felt and struck with a sound; then, by introducing a knife through the perineum above the bowel, the cyst was opened and the stone extracted.

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* Roy. Coll. Surg. Mus., 2036. Greatly enlarged prostate; lithotomy. Calculus remaining in the bladder, two other stones having been removed. (Sir W. Blizard.)

Enveloping folds of mucous membrane are sometimes met with, the stone thus eluding the grasp of the forceps. This mechanical difficulty must be overcome by manœuvre with the forceps, or by the more direct and safe means of the finger and scoop. An insufficiently injected bladder would be more likely to present this difficulty.

Hour-glass contraction of the bladder, the stone being placed in the upper compartment, will probably necessitate recourse to the high or supra-pubic operation of lithotomy.

An *adherent* state of the calculus has been doubted by some authors; but an indisputable case is recorded by Mr. Shaw in the "Transactions of the Pathological Society," vol. vi. The adhesion of the mucous membrane to the stone was effected by fibrous tissue, the fibres dipping into the calcareous substance; and this union was so firm that it resisted separation by tearing with the forceps. I have figured a specimen (p. 673) in which there were numerous small adherent calculi; and in another specimen at the Royal College of Surgeons, two calculi of some size (p. 674) were firmly attached to the mucous coat of the bladder. In extracting phosphatic calculi, the deposit of rough calcareous matter on the rugæ of the bladder must not be mistaken for a distinct calculus; any attempt to remove the former would, of course, prove disastrous by tearing away the mucous membrane with the deposit.

Position of the stone.—Two parts of the bladder, in either of which the calculus may be situated, offer considerable difficulty to *seizure* of the stone. When lodged in a depression behind an enlarged prostate (Fig. 884), the stone must be brought up by tilting the bladder with the finger introduced into the rectum, and then using a long curved pair of forceps or a curved scoop. When situated above the pubes anteriorly, towards the upper fundus of the bladder (Fig. 885), the stone must be lowered by compressing the abdomen, as Aston Key recommended, and then seized with a curved forceps or the curved scoop. In one such case, Sir B. Brodie found the stone both encysted and adherent. Raising the pelvis will sometimes enable the forceps to grasp the stone, a resource which proved successful in a case on which Mr. Coulson operated.

FIG. 884.*

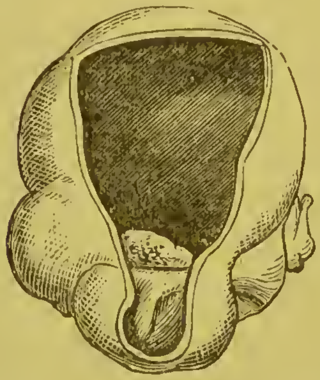
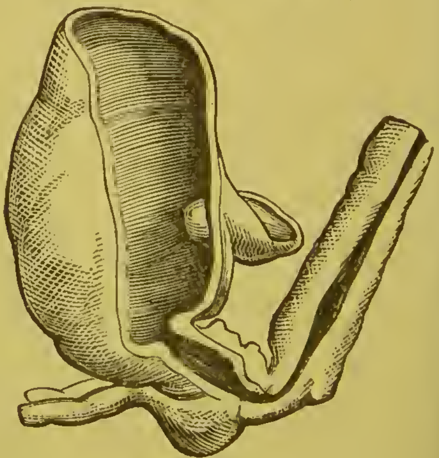


FIG. 885.†



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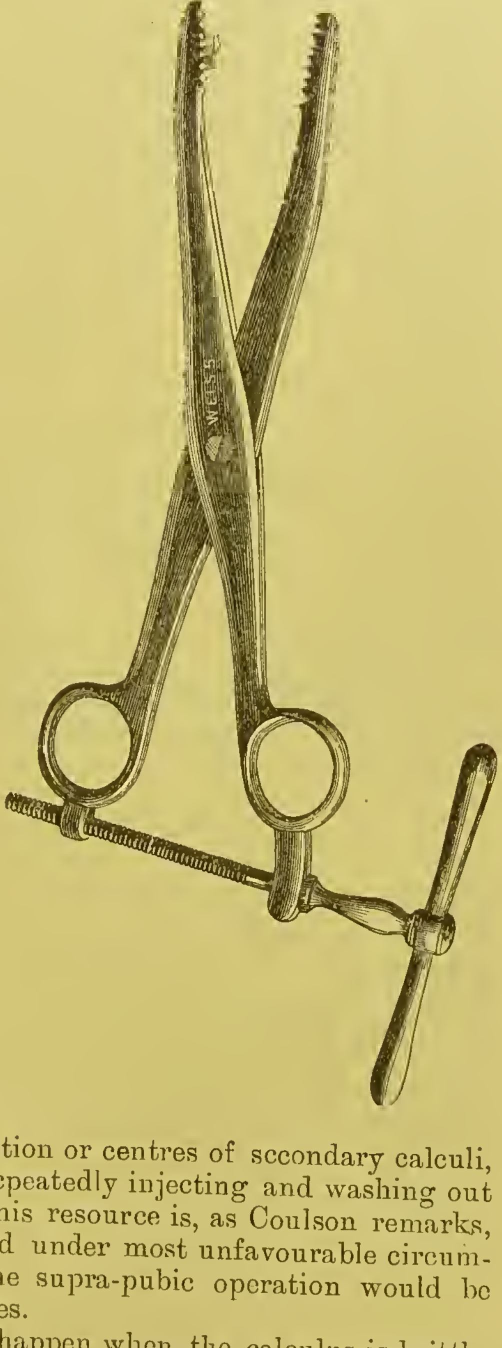
* Roy. Coll. Surg. Mus., 2028. A deep pouch at the base of the bladder, just behind the prostate; and, in this post-prostatic depression, a rough calculus, more than an inch in diameter, is lying almost concealed. (Liston.)

† Ibid., 1983. (Liston.)

Shape and Size of the Stone.—The shape of the stone may offer some difficulty to its *seizure* with the forceps. A round irregular stone, as a mulberry calculus, is grasped less readily than a flattened, smooth stone, which lies easily within the blades of the forceps. Irregular-shaped phosphatic calculi present the greatest difficulty.

Both the shape and large size of the stone may offer considerable obstacles to its *extraction*. Three resources are practicable:—(1) section of the right lobe of the prostate, forming the bilateral section of this body; (2) crushing, splitting, or drilling and breaking up the stone in the bladder—by means of strong lithotomy-forceps, cutting forceps, or lithotrites,—thus performing perineal lithotrity; (3) the recto-vesical or the supra-pubic operation of lithotomy. Of these procedures, section of the prostate is most practicable and the safest. It was recommended by Liston, Martineau, Stanley, and Coulson, rather than use undue force in attempting to gradually dilate the ordinary prostatic incision, which would cause bruising or laceration. The forceps still grasping the stone is held fast by an assistant, and the right lobe of the prostate is then incised towards the right tuber ischii, by passing the knife or a blunt-pointed bistoury along the blade of the instrument as a director. In this way, Martineau often enlarged the opening, repeating the incision two or three times. Crushing the stone in the bladder through the perineal wound, is a more dangerous procedure; the instrument required must be of some size, and strong. (Fig. 886.) Its application may be attended with some injury to the bladder, which is often firmly contracted on the stone; and the fragments of stone, as sources of irritation or centres of secondary calculi, must be thoroughly removed by repeatedly injecting and washing out the bladder with tepid water. This resource is, as Coulson remarks, an operation of lithotrity performed under most unfavourable circumstances. The recto-vesical or the supra-pubic operation would be preferable to crushing, in most cases.

FIG. 886.*



Fracture of the stone is apt to happen when the calculus is brittle, or soft; breaking into several sharp fragments, or squashing into a soft mortar-like mass. It occurs mostly to phosphatic calculi. This breaking down of the stone results usually from too firm a grasp with the forceps, either lest the stone should slip away, or by pulling too high up and coming in contact with the pubic arch, or in consequence of the pressure requisite in extracting a large-sized stone. The fracture generally leaves a central stone in the blades of the forceps, which should be extracted, and the detached fragments removed by the repeated introduction of this instrument or the scoop, and the bladder thoroughly washed out. Detritus will probably still remain, and small fragments may be discharged through the wound for some days; then the bladder should be injected daily through a catheter passed down the urethra, and the water made to escape freely by the wound, the stream carrying with it particles of calculus. This plan should be continued until no more detritus is brought away. If the wound has healed, the fragments remaining must be washed out through the urethra, by means of a catheter, as after lithotrity.

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* Erichsen's stone-crusher, for large calculi.

Rickety deformity of the pelvis, although not a common cause of difficulty in lithotomy, may present insuperable obstacles in extracting the stone. If the brim of the pelvis be narrowed in its antero-posterior diameter, the difficulty of extraction will be increased in children, owing to the high position of the bladder. Narrowing of the pubic arch, which is always narrow in children, may quite preclude extraction, or even the introduction of the forceps. These conditions should be ascertained *before* operation, and supra-pubic lithotomy performed.

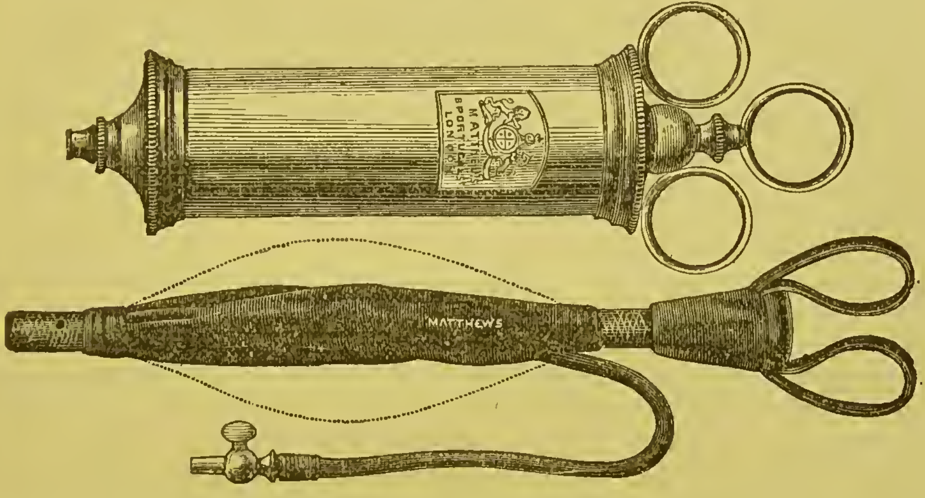
The *Accidents* which may happen during the lateral operation are:—(1) wound of the rectum; (2) hæmorrhage, arising either from the vessels necessarily divided, or from the pudic artery or the artery of the bulb, or from certain accidental deviations of these vessels, and from the prostatic or other veins; (3) wound of the bulb; (4) missing the urethra and entering the bladder beyond the prostate; (5) penetration of the posterior part of the bladder from within its cavity.

The three first-named accidents have already been adverted to in considering the parts to be avoided in performing the lateral operation.

(1.) *Wound of the rectum* is important according to its size or situation. The accident is more liable to occur in old persons, the rectum —as Deschamps observed—being dilated, and even wrapped around the prostate on either side. A small puncture, low down near the anus, may be left to itself; a little feculent fluid escapes from the perineal wound for some days, along with the urine, but as granulation closes up, this ceases, and the urine is transmitted through the urethra. A larger-sized aperture, or when situated higher up the bowel, had better be dealt with at once and in the same way as fistula in ano. The bowel should be laid open into the perineal wound, by an incision from the accidental aperture downwards through the sphincter ani, so as to form one cavity. Granulation from the bottom may then restore the continuity of the bowel. Otherwise, a recto-vesical fistulous communication will remain.

Hæmorrhage must be managed on ordinary principles; by ligature or torsion of any distinctly bleeding artery that may be accessible, or by pressure. The artery of the bulb is the principal source of serious, or even fatal hæmorrhage; and so also would be the internal pudic, as it can scarcely retract within the obturator fascia overlying it; but this vessel is well protected under cover of the ramus of the ischium. Either vessel is best secured by compression; ligature being inapplicable in most cases, as the vessels cannot thus be reached. Compression is applied most effectually by means of digital pressure, provided the bleeding vessel can be commanded with the finger, and relays of assistants are at hand. In the course of fourteen or twenty-four hours, according to cases related by South and Brodie, continued digital pressure succeeded in permanently stopping hæmorrhage from these vessels. The ramus of the bone offers an excellent counter-resistance to the finger. Ligature has been applied to the internal pudic by Sir B. Brodie, and by Dr. Physick, in America; the former Surgeon using a flexible silver needle. *Oozing* hæmorrhage, of a persistent character, may be effectually arrested by plugging the perineal wound. This is precisely the condition in which Liston's gum-elastic tube may be used with advantage, while free vent also will thus be given to the urine. The track of the wound is plugged with dossils of lint around the tube; or more conveniently, by pieces of sponge introduced into a conical bag of oiled silk attached to the tube, as devised by Mr. Hilton, or the lithotomy tube constructed by Messrs. Matthews, with syringe for the injection of water, may be used (Fig. 887.) Liston's tube is kept free of coagula by the occasional introduction of an oiled feather. *Venous* hæmorrhage, proceeding chiefly from the prostatic plexus of veins, may be arrested in like manner. Hilton's contrivance has here proved very successful. Sir B. Brodie lost a patient within a few hours after operation, from venous hæmorrhage; every effort having been made in vain to arrest it. *Retrocedent* hæmorrhage, the blood, arterial or venous, passing back into the bladder, sometimes occurs and to an alarming extent. Bloody urine escapes by the wound, but the bladder becomes distended; there is dulness on percussion above the pubes, and faintness ensues. Injections of cold water should be used to wash out the bladder; and ligature or plugging applied, according to the nature and source of the hæmorrhage.

FIG. 887.



(3.) *Wound of the bulb* is an accident of no serious consequence. This opinion was held by Mr. Skey, and certainly it would seem to be confirmed by the frequency with which the bulb has been wounded with impunity. But the accident has given rise to phlebitis and pyæmia.

(4.) *Missing the urethra, and entering the bladder beyond the prostate,* allows of infiltration of urine into the pelvic cellular tissue. Diffuse inflammation and death will almost necessarily follow. Yet this fatal accident has occurred, once in a way, to the most skilled lithotomists. To avoid it, the nail of the left forefinger should be lodged fairly in the groove of the staff, before planting the point of the knife over the nail.

(5.) *Penetration of the posterior part of the bladder* is liable to occur from passing the knife too deeply along the groove of the staff; the point may slip out and penetrate the posterior wall of the bladder. Hence the advantage of the button-headed bistoury. An insufficiently injected bladder would be more exposed to this accident. I have never yet known it to happen, although I have heard of such a case.

In *children*, the accidents specially incident to lateral lithotomy have been fully considered in describing the operation as performed before puberty or at an earlier period of life.

After-Treatment.—When no accident has occurred during the operation, the treatment after lateral lithotomy is simple. The patient is placed on his back in bed, with his legs apart and the knees somewhat raised on pillows. The urine will thus drain away through the wound, as it is secreted, preventing the chance of urinary infiltration. A draw-sheet, covered with mackintosh cloth, having been previously placed under the buttocks, will enable the nurse to keep the patient clean and dry without altering his position. No dressing is required; a sponge or small spittoon-pot is placed under the wound against the nates, to catch the urine as it drops. *If* Liston's gum-elastic tube has been passed up the wound into the bladder, and there retained by perineal tapes, this channel can be kept free from coagula and open for the distillation of the urine, by occasionally introducing an oiled feather. When I was a student, this precaution was observed so diligently, that the dresser in attendance sat by the patient's bed-side, the night after operation, for the purpose of thus freeing the tube. It was retained for about twenty-four hours in a child, and about forty-eight hours in an adult. By that time its retention was thought unnecessary; the sides of the wound having become glazed over with lymph, whereby the risk of infiltration will have ceased. An opiate should be given, and repeated when necessary, to secure sleep, or at least quiescence; and diluent drinks allowed plentifully, with light fluid food, as milk, arrow-root, or beef-tea, during the first three or four days. In an elderly person, it may be requisite to soon have recourse to stimulants. *Retention* of urine sometimes occurs, and must be instantly relieved by passing a gum-elastic catheter or the finger up the wound to the neck of the bladder. Warm fomentations and opiates will then allay pain and irritation. About the fourth or fifth day, the urine may suddenly cease to escape through the wound, and be discharged through the urethra;—the patient "wets," as nurses are accustomed to understand it. This, however, seems due to a temporary turgescence in the wound, resulting from inflammatory swelling which occludes the outlet; subsiding in a day or two, the urine again escapes by the wound. The same temporary discharge of urine through the natural passage may happen at an earlier period,—within twenty-four hours after operation.

It is not at all a favourable sign. Urine having again returned through the wound, the quantity gradually diminishes during granulation and contraction; a portion passes permanently by the urethra in a week or ten days, and the wound closes about the end of a fortnight to three weeks. The cure is completed in from thirty to forty days. In the case of a large mulberry calculus which I removed from a man sixty-five years of age, the patient returned sound to Hastings, at the end of a month. Phosphatic calculi generally entail the longest period for recovery after operation.

Morbid conditions of the wound, as that of sloughing or suppuration, must be treated accordingly.

Secondary hæmorrhage not unfrequently occurs; apparently, as Sir B. Brodie suggests, from the detachment of a slough. Compression of the bleeding vesesls will prove more effectual than ligature.

Urinary fistula sometimes remains, with incontinence of urine, temporary or permanent. This result is met with mostly in children, and it generally ceases as age advances. The fistulous tract may perhaps be closed by occasionally passing a probe coated with nitrate of silver, or by the galvanic-wire cautery.

Incontinence alone may occur, particularly in childhood, if the patient be allowed to get up too soon, before the sphincter of the bladder has recovered its tone. *Impotency* is a more rare result, from wound or injury involving the ejaculatory ducts in the substance of the prostate. *Fæcal fistula* may be the result of a wound of the rectum; or of bruising of the bowel, either by a forcible use of the finger in the act of protecting it, or during extraction of the stone.

CAUSES OF DEATH, AND RESULTS, AFTER LATERAL LITHOTOMY.—The principal *causes of death* are:—(1) Age; (2) Large Calculus and Pelvic Cellulitis; (3) Disease of the Kidneys; (4) Hæmorrhage; (5) Shock; (6) Cystitis; (7) Peritonitis; (8) Pyæmia.

(1.) *Age* has a remarkable relation to the mortality after lithotomy. The lateral operation is rarely fatal in childhood; a dangerous operation in middle life; and a perilous or fatal operation in old age. This operation has been found to be four times as fatal in adults as in children, at the Norfolk and Norwich Hospital. Cheselden lost only one patient out of thirty-five under ten years of age; and of the cases recorded by Mr. South (in Chelius's Surgery) as having been operated on at St. Thomas's Hospital during a period of twenty-three years, the mortality, at that period of life, was only 1 in 58. Coulson's table of 2972 cases shows an increasing mortality at each successive decennial period:—under ten years, it is 1 in 13; it thence gradually rises, after ten to eighty years, to 1 in 9, 1 in 6, 1 in 5, 1 in 4, 1 in 3·65, 1 in 3·23, 1 in 2·71. The mortality at *all ages* rates at 1 in 9, according to the St. Thomas's table of 125 cases where the age was stated; but in 1827 cases, collected by Sir H. Thompson from the Metropolitan and Provincial Hospitals, the average mortality was higher,—nearly 1 in 8; and in Coulson's general table of 6505 cases, male and female, the average mortality rises still higher,—to 1 in 6·56, or about 2 in every 13 cases.

(2.) *Size of the Stone.*—A large stone is far more dangerous than a small one, in regard to the result of operation; and the danger increases with the size, or *weight*, of the stone. This may be due, either to bruising and laceration of the neck of the bladder, or to infiltration of urine and pelvic cellulitis, as the results of forcible extraction. Crosse's table of 704 cases, in the Norwich Hospital, shows the increasing danger according to the size of the calculus, estimated by its weight. When the weight of the stone was under one ounce, the deaths were in the proportion of 1 in 11·25 cases; from one to two ounces, 1 death in 6·61 cases; from two to three ounces, 1 in 2·18; from three to four ounces, 1 in 1·57; and from four to five ounces, 1 in 1·66 cases. The chance—observes Mr. Coulson—which a patient has for recovery after lithotomy can, therefore, be calculated beforehand, and independent of every other consideration, from the ascertained dimensions or weight of the stone. Out of 90 cases of death after lithotomy, collected by this author, by far the highest proportionate number—22—resulted from infiltration of urine, inducing pelvic cellulitis. Sir H. Thompson concurs in the frequency of pelvic cellulitis as the cause of death, but he would attribute it to bruising and laceration of the neck of the bladder, rather than to urinary infiltration; this opinion resting on the fact that, in children, the boundaries of the prostate are almost always overstepped by the knife, yet without giving rise to infiltration of urine.

(3.) *Disease of the Kidneys.*—Chronic pyelitis, or chronic nephritis resulting in degeneration of the kidneys with albuminous urine, may be said to represent that diseased condition of the kidneys which is most prejudicial to recovery after lithotomy.

In estimating the comparative mortality of lithotomy in *adults* and *children*, two elements seem to be in favour of the latter :—at an early period of life, the kidneys are usually sound, and the stone of small size,—thus entailing less liability to injury of the neck of the bladder, or to infiltration of urine, followed by pelvic cellulitis.

In children, death generally results from some accidental violence; as the formation of a false bladder in the recto-vesical space, or disruption of the neck of the bladder from the membranous urethra. In adults, however skilfully the operation may have been performed, the state of the kidneys and the size of the stone may severally lead to a fatal issue.

Suppression of Urine may be mentioned as a rare cause of death; the kidneys being found congested, but not otherwise structurally diseased.

(4.) *Hæmorrhage* is liable to occur primarily, or secondarily—after the operation; in the latter case it takes place in about a week or ten days, or even a fortnight. Primary hæmorrhage is rarely fatal; in Liston's experience, one such case happened in 100 operations; and Coulson has not experienced dangerous hæmorrhage frequently, although out of the ninety cases of death after lithotomy, which he collected, no less than eleven patients died from hæmorrhage, primary or secondary. In France, Begin affirms that it is the cause of death in one out of every four deaths; and Boyer regards hæmorrhage as one of the chief dangers of lithotomy.

(5.) *Shock*, as the cause of death, is very uncommon; and it generally happens in old people.

(6.) *Cystitis* is also a rare cause of mortality; although Boyer attributes three-fourths of the deaths after lithotomy to this cause, or its consequences by extension to the kidney or peritoneum.

(7.) *Pelvic cellulitis*, as arising from infiltration of urine into the cellular tissue around the neck of the bladder, would appear to be the inevitable consequence of a too free prostatic incision; yet this condition must be very rare, neither Sir W. Fergusson nor Mr. Spence having met with it in any post-mortem examination of a lithotomy case. The symptoms supervene in from twenty-four to forty-eight hours.

(8.) *Peritonitis*, as a consequence of cystitis or pelvic cellulitis, may thus cause death; but peritonitis *per se* is a rare event, especially in adults.

(9.) *Pyæmia* may be consequent on peritonitis; but it more frequently arises from inflammation of the prostatic plexus of veins, and generally in old persons, at the end of a week or fortnight. In one case, however, pyæmic infection supervened as late as the fourth week, when the wound had nearly healed (Spence). As a cause of mortality after lithotomy, pyæmia would seem to be not uncommon; ten deaths having thus occurred in the ninety cases referred to.

In considering the results of lithotomy, no Surgeon should judge from his own experience of a *limited* number of successful cases, in succession. I, for instance, have not yet lost a case; and Surgeons of very extensive experience are well aware of the fallacy of these serial cases. It has been truly said that "ten, twenty, thirty cases may succeed without interruption, and the operator flatters himself he is never to lose a patient; when two or three deaths follow in quick succession, and reduce him to a level with his neighbours, or at least within the limits of variation which the analysis of a large number of cases indicates."

Recurrence of Stone.—After the lateral operation of lithotomy, and after the median operation also, a second stone sometimes forms. The liability to this recurrence of calculus, and its relation to various circumstances, has been statistically investigated by Mr. C. Williams, of the Norfolk and Norwich Hospital. From the opening of the Hospital in 1772, to November, 1863, or during a period of ninety-one years, 923 cases of stone in the bladder underwent some form of lithotomy, excluding two cases of lithotrity; of these, twenty-four suffered a relapse, and underwent a second operation. The proportion of such cases to the whole number of stone patients is 1 in 38·45. Of the twenty-four cases of recurrence, and a second operation of lithotomy, nineteen were cured, and five died; three had stone a *third* time, two of which were cut and recovered, the third was deemed unfit for operation. All the patients were males, no instance having shown itself of recurrence in the female. In respect to *age*;—six of the cases were under ten years of age; two between ten and twenty; one between twenty and thirty; four between thirty and forty; two between forty and fifty; two between fifty and sixty; and seven between sixty and seventy. One death occurred below forty years of age; and four above that period of life. The *period* of return varied from one year to twelve years; the average period was thirty-three months. *Lateral* lithotomy was performed in all the cases, excepting eight; two of which were cut on both occasions by the median operation, and in four this operation was resorted to on the second occasion. In fourteen, the calculi were removed in a perfect and entire condition at the first operation; while in eight, the calculi were broken in the extraction; in one, the stones were very small and numerous; and in the remaining one, a sacculated stone was left undetected in the bladder. The *nature* of the second calculus was not in all cases the same as that of the first; in sixteen, the second formation had the same composition as the first, nine of which were phosphatic, while seven consisted of lithic acid and the lithates; the phosphates succeeded the lithates in five, and the oxalates in two cases.

MEDIAN LITHOTOMY.—The Median operation of lithotomy is so named, because the incision is made in the *middle line* of the perineum. But this operation comprises two methods of procedure in relation to the *prostate:* a vertical section of the membranous urethra alone, and then dilatation of the prostate with the neck of the bladder,—"litheetasy" in the male, as it might be termed; or a vertical section of the prostate, as well as of the membranous urethra. Formerly the one was called also the "Marian operation," as having been advocated by Sanctus Marianus; and the "operation of the apparatus major," from the number of instruments employed in performing it.

The Old Marian Operation.—A grooved staff was introduced into the bladder, and the patient trussed up as for lateral lithotomy; the operator then made a vertical and nearly central incision, just to the left of the raphé, and terminating just above the anus. The *membranous urethra* was opened in the groove of the staff, and the knife being kept well in the groove, a long probe was passed by the side of the knife into the bladder. Both staff and knife were then withdrawn, leaving only the probe as a guide to the bladder. Along this instrument two iron rods or "conductors" were introduced, and by separating their handles, the prostate and neck of the bladder were dilated —or, as John Bell observes, the operator "tore open the prostate." The conductors were held aside, and "dilators" introduced to make way for the forceps, wherewith the stone was extracted. Thus, as Le Cat expressed it, the two principles of the Marian operation were— "small incision, much dilatation." Vacca revived the Median operation, and practised also a vertical section of the *prostate;* thereby avoiding laceration of this part, but endangering the rectum.

Allarton's Operation.—The Marian operation had long fallen into disuse, but of late years it has been revived and slightly modified by Mr. Allarton; and with his name Median lithotomy is now generally associated, in this country.

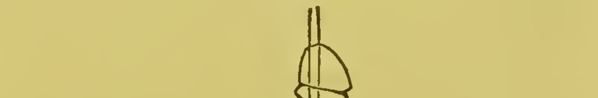
The operation is performed much in the same way as by the old Marian operation, up to the introduction of the probe into the bladder; when the *forefinger*, instead of dilators, is passed along the probe, and with a semi-rotary motion, the prostate is thus dilated. The points to be attended to are these:—the curved staff is held by an assistant, firmly, perpendicularly, and hooked up against the pubes; the forefinger of the left hand is introduced into the rectum, so that its point shall steady the staff in the prostate; a straight, sharp-pointed knife is entered into the perineum, in the *middle line*, about half an inch above the anus, and carried on steadily till it strikes the groove of the staff at the membranous urethra in front of the prostate,—a depth of about one inch and a half; the knife is moved along the groove towards the bladder for a few lines deeper, and then withdrawn, at the same time cutting upwards an external incision of three-quarters to an inch and a half, according to the presumed size of the stone. A long ball-pointed probe is slid along the groove of the staff into the bladder.

and the latter instrument then withdrawn, as in the old Marian operation. But the left forefinger is passed along the probe into the bladder, and used to dilate the prostate and neck, serving also as a guide to the forceps. When the stone is free, it comes at once into contact with the finger, and, if of moderate size, escapes readily into the wound on withdrawing the finger; the patient having power to strain upon and thereby facilitate the extraction of the stone.

The advantages claimed for the median, over the lateral operation, are—that the incision being strictly in the median line, no vessels are divided, and no gaping open wound is left; the integrity of the bladder being preserved, and no chloroform given, the patient himself helps to expel the stone. This operation is most suitable for *small* stones, and where lithotrity is inadmissible.

The *results* of Median, as compared with those of Lateral, Lithotomy have been decidedly unfavourable; a difference owing doubtless to the fact that in Median Lithotomy, *without* section of the prostate, this gland and the neck of the bladder are bruised and lacerated by the dilatation—whether with " dilators " or the " forefinger." Thus, comparing the results of forty-four cases of Median Lithotomy with the last forty-four current cases of lateral lithotomy in the Norwich Hospital, 1863, Mr. Williams's table shows that of the median cases eleven died, whereas of the lateral cases only two died. This may be a too unfavourable estimate of the median operation; for, of twenty-three cases, Mr. Teale reports that twenty recovered, and only three died. Fifteen were in adults, with a proportion of thirteen recoveries and two deaths. The average period of recovery—in the former series—was seven days in favour of the median operation; thirty days instead of thirty-seven, as after the lateral operation. The weight or size of the calculus much affects the result. There was no instance of recovery when the stone exceeded three drachms and two scruples; except in one case, that of a stone weighing four and a half ounces, but the extraction of which was followed by sloughing of the rectum and perineum, with recto-vesical fistula. Nor was there an instance of recovery where the stone exceeded an inch and a half in its long diameter, and an inch and an eighth in its short axis, otherwise than the exceptional case mentioned.

Fig. 888.



Rectangular Staff Operation.—Dr. Buchanan of Glasgow introduced this procedure, which is a modification of the median operation. He uses a rectangular staff, with the short branch grooved at its side. This instrument having been passed into the bladder, the angle is made to correspond in situation with the front of the prostate, the lower or grooved branch lying parallel to the rectum. The left fore-finger is passed into the rectum, and a long straight knife, held with the blade horizontal and the edge turned the left, is made to enter the perineum opposite the angle of the staff, and passed straight into and along the groove into the bladder. (Fig. 888.) The membranous urethra is thus left *untouched*. In withdrawing the knife, a lateral section of the prostate is made in its left lobe; and at the same time, an external incision downwards and outwards, round the upper and left side of the anus, to about an inch and a quarter in extent.

Certain features in this operation are adduced in its favour:—the more direct line to the prostate, which, at the angle of the staff, is situated close to the surface of the perineum; the membranous portion of the urethra is avoided; all blood-vessels are out of the way, and consequently there is no important hæmorrhage; the rectum is less liable to be wounded; and there is less risk of deep-seated infiltration of urine.

BILATERAL LITHOTOMY.—Dupuytren's operation consisted in making a semilunar incision, transversely, in front of the anus; the convexity of this incision being upwards, and the horns extending laterally to between the anus and the tuberosity of the ischium on either side. The tissues were carefully divided upwards to the membranous urethra, avoiding the rectum; this portion of the urethra was opened by a median incision from before backwards, with a double-edged bistoury; then, the curved double-bladed lithotome was passed along the groove of the staff into the bladder, the staff withdrawn, and the concavity of the lithotome being directed downwards, the blades were opened, and, in withdrawing the instrument, both sides of the prostate were divided obliquely downwards and outwards to the requisite extent. The extraction of the stone is then accomplished in the usual manner.

The principal advantage of this method is the facility it offers, by a free prostatic opening, for the extraction of large calculi; an advantage, however, which can be gained, when necessary, by bilateral section of the prostate, in the ordinary lateral operation. The risk of hæmorrhage is about equal in both these methods; but in the bilateral prostatic section, both seminal ducts being divided, the Surgeon incurs the additional danger of thus emasculating the patient.

Bilateral lithotomy has been performed chiefly by French Surgeons —Roux, Sanson, Blandin, and Velpeau; and in America by Professor Eve, of Nashville University.

The results of this operation are unfavourable; 19 deaths having occurred in 85 cases, or 1 in 4½ cases.

Medio-bilateral Operation.—Civiale, in 1836, modified the median operation by his medio-bilateral procedure. It consisted of a median perineal incision, followed by a transverse section of the prostate with a straight double-bladed lithotome, which was passed into the bladder through the membranous urethra, along the groove of the staff, and the blades withdrawn open.

QUADRILATERAL SECTION OF THE PROSTATE has been recommended by Vidal de Cassis, in cases of *very large* stone; no matter what the direction of external incision may be, so that it is not too small—

whether oblique, vertical, transverse, or curved. The principles of this operation are—to have one large external incision, and many small internal ones. The two first sections of the prostate are made along the inferior oblique diameter of the gland on either side, which will prove sufficient when the stone is of moderate size; but two superior oblique sections must be added, first one and then the other, when the stone is very large.

Recto-vesical Operation.—Lithotomy through the rectum is claimed by Sanson as his procedure. A grooved, curved staff having been introduced into the bladder, a vertical incision is made, corresponding to the raphé of the perineum, and dividing the sphincter ani and lower part of the rectum. Continuing the dissection, the membranous portion of the urethra and prostate are exposed. A vertical section of the prostate is then effected, either by passing the knife along the groove of the staff from before backwards, or by entering the knife behind the prostate and drawing it forwards on the finger in the groove of the staff. A portion of the base of the bladder, uncovered by peritoneum behind the prostate, has even been divided. The staff is withdrawn, the finger introduced, and the stone extracted with the forceps. Recto-vesical lithotomy was practised in this country by Mr. Lloyd.

This operation has been recommended on the ground of its affording an easy passage for extracting instruments, and as being free from the risk of hæmorrhage. But there is great risk of wounding the peritoneum and vesiculæ seminales; and of the subsequent occurrence of urinary infiltration, the passage of fæces into the bladder, and recto-vesical fistula. Coulson has seen cases of permanent fistulous communication. This method of lithotomy has, therefore, been discarded; and it cannot be deemed advisable even in cases of impacted calculus in the wall of the bladder.

The *results* are very unfavourable; in 185 cases thus operated on, 38 died, being a mortality of 1 in 4·86. But the mortality varies according to the mode of operation; and adversely with regard to the method by incision extending *behind* the prostate. Thus, in six such cases by Dupuytren, three of the patients died from pelvic cellulitis. The risk of recto-vesical fistula is increased by this incision; the remaining three cases having had that result. Of seven cases by Vacca, four or five had the same result; and also three out of four cases in which Geri operated. As compared with lateral lithotomy; at Turin, in five cases of the recto-vesical operation, three were fatal; whereas eleven patients, submitted to the lateral operation, all made speedy recoveries.

Supra-pubic, Hypogastric, or High Operation.—The *size* of the calculus, or the state of the *perineum*, especially with regard to the pelvic outlet, may render perineal lithotomy, in any other form, impracticable. Under these circumstances, or other impracticable conditions, recourse may be had to supra-pubic lithotomy. In *children*, and persons below twenty years of age, the bladder stands high above the pubes, and presents a portion uncovered by peritoneum, which is freely accessible; under eight years, the peritoneal reflection from the bladder does not generally reach lower than an inch and a half to two inches from the navel. In *old* persons, especially when emaciated, the bladder lies deep in the pelvis, behind the symphysis pubis, and would be difficult to reach, epecially in a corpulent person. Chronic cystitis, resulting in a thickened state of the bladder, will also render the operation difficult.

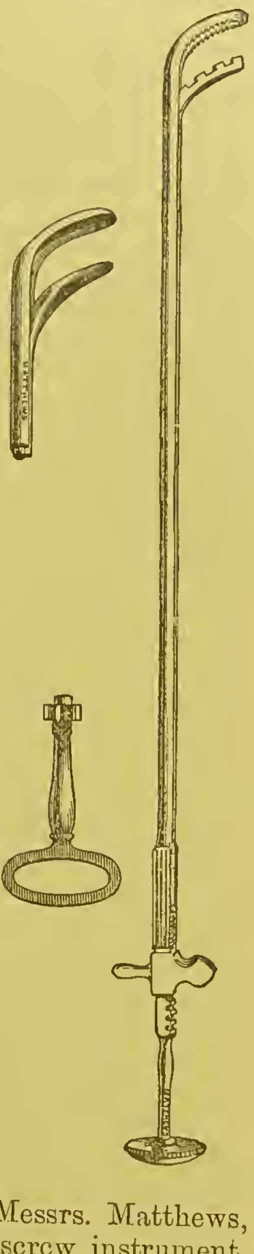
In order to perform supra-pubic lithotomy, the bladder must be made to rise above the pubes; and this may be accomplished either by full distension of the bladder with water, or by means of a catheter or other instrument introduced through the urethra into the bladder, so that its point shall project above the pubes. Both means are adopted to insure a presenting part or point of the bladder in that situation. The operation consists in making a vertical incision in the middle line, above the pubes, carried upwards to about three inches in length; the linea alba is exposed, and the incision carried through the muscular wall of the abdomen and fascia transversalis; the projecting part of the bladder, uncovered by peritoneum, is sought just above the symphysis, and opened on the point of the instrument within its cavity; this incision being prolonged downwards towards the neck of the bladder with a probe-pointed bistoury, sufficiently to admit the finger. The forceps is then passed in, and the stone extracted. Accidental fracture of the calculus will present a difficulty of more consequence than when it occurs in the lateral operation; for the bladder cannot readily be washed out, and, a fragment remaining, the recurrence of stone is inevitable. Various instruments have been devised wherewith to puncture the bladder from within, when reached by the incision. Thus, the sonde-à-darde is a puncturing instrument, combining a trocar concealed in a catheter; and this is used by Civiale. The performance of this operation is much more difficult than it would appear to be.

The *after-treatment* is simple; urinary infiltration is prevented by placing the patient on his back, and it may perhaps be advisable to introduce a gum-elastic catheter into the bladder, leaving it there for a few days until union of the wound has taken place. Formerly, it was thought necessary to close the bladder by sutures, and even to make a counter-opening through the perineum into the membranous urethra or the neck of the bladder, with a view of securing a free drain for the urine. These complications are now entirely discarded, whenever the operation is occasionally resorted to.

The *results* of this operation are, however, singularly fatal. Professor Humphry, of Cambridge, has shown that in 104 cases, 31 were fatal, mostly in consequence of peritonitis and urinary infiltration; a mortality of 1 in 3·08. He had himself one successful case, and other Surgeons, especially M. Souberbielle, Sir Everard Howe, Carpue, Kirby of Dublin, and Dr. Carpenter of Pennsylvania, have also had occasionally a successful result. But it should be remembered that the operation is had recourse to when the stone is of unusually large size, being coupled with a narrow pubic arch; and, the lateral operation inapplicable, the results of the two methods cannot fairly be compared.

LITHOTRITY.—The operation of breaking down the stone in the bladder, so as to allow of its extraction, or discharge, by fragments through the urethra, was early devised and attempted, in some way, as a substitute for the cutting operation of lithotomy. This procedure was noticed by Hippocrates amongst the Greeks; by Albucasis, of the Arabian school; by Franco, Guido de Cauliaco, Hildanus, Haller, and other authors down to the end of the last century. In 1813, Gruithuisen, a Bavarian Surgeon, published two memoirs on the subject, describing his instruments for the drilling or *boring*, and then crushing the fragments, of stone in the bladder. But these isolated and imperfect attempts failed to introduce Lithotrity into the practice of Surgery. Civiale, in 1817, then a poor student, first succeeded in drawing attention to Lithotrity, by constructing certain boring instruments, which he brought before the notice of the French Minister; and continuing his labours in subsequent years, followed by Elderton in 1819 ("Edin. Med. and Surg. Journal"), Amussat in 1822, and Leroy d'Etiolles in 1823, this method of removing stone from the bladder acquired a recognized and established reputation in France. The first operation of lithotrity on the living subject was performed by M. Civiale, Jan. 13, 1824. Subsequently, in this country, the first *crushing* instrument of any value, was invented by Mr. Weiss, in 1824. It consisted of two blades, sliding one within the other, and worked by a screw at the handle. With a somewhat similar instrument, in 1825, Mr. Hodgson, at the Birmingham Hospital, first performed the operation of crushing stone in the bladder. Baron Heurteloup in 1830, and Costello afterwards, devised an instrument for *hammering* the stone to pieces; but the crushing procedure prevailed, and was mainly brought into practice by Sir B. Brodie. The oval slit in the under or female blade, for the escape of detritus in using the lithotrite, was suggested by Mr. Oldham, a gentleman connected with the Bank of England. Since the period referred to, lithotrity has received the special attention of Coulson, Sir W. Fergusson, Skey, and Sir H. Thompson. The latter Surgeon may justly be entitled the champion authority respecting this operation, he having presented the results of his extensive experience in "An Analysis of 184 Consecutive Cases of Stone in the Bladder of the Adult, treated by Lithotrity" ("Med.-Chir. Trans.," 1870); and during the present year (1878), this series has been extended to 500 cases of operation,—including the cases of Lithotomy.

Fig. 889.



The *Lithotrite*, or instrument for crushing the stone, now in general use is Weiss's "newly invented lithotrite," or Sir Henry Thompson's admirable lithotrite. It enables the operator to exercise powerful, yet nicely regulated screw-pressure; its cylindrical and finely fluted handle aids the sense of touch, and the whole is a light and delicate instrument. Another form of instrument was frequently used by Sir W. Fergusson—a rack-and-key lithotrite (Fig. 889), as made for him by Messrs. Matthews, but which is less generally employed. I prefer a screw instrument, and especially Thompson's lithotrite, for the three reasons just stated. The instrument is now made without a fenestrum or oval aperture in the under blade. A steel sound, for detecting fragments, is also very serviceable, and an injecting apparatus will be required, consisting of large-eyed catheters of different sizes, and a strong, large-sized brass syringe, the nozzle of which fits the catheters.

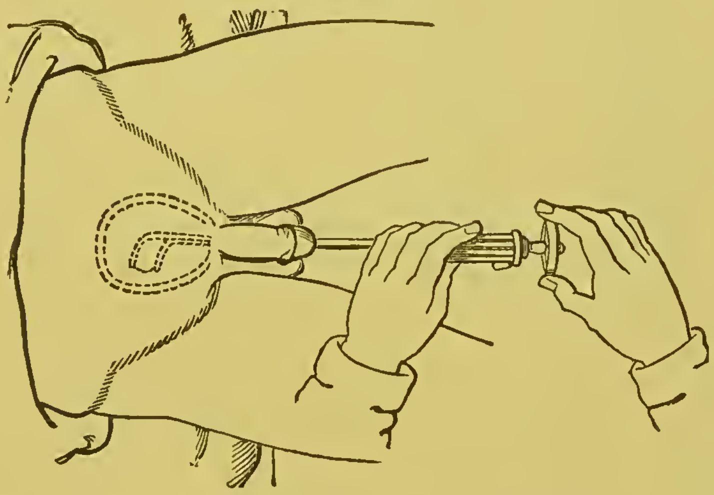
Preparation of the Patient for Lithotrity.—Prior to any operation for breaking up a stone in the bladder, it is absolutely necessary that not only should the general health be attended to, but that the bladder, more especially, should be brought into as quiet a condition as possible. Freedom from vesical irritability or inflammation is more important in relation to lithotrity than to lithotomy; the former operation being perhaps an unavoidably more prolonged procedure within the bladder, a repeated operation, and one which leaves fragments of stone behind as a continued source of irritation during their discharge. Hence, if the bladder or kidneys be diseased, lithotrity should be postponed or abandoned.

Lithotrity is thus performed:—The patient having been placed recumbent on a bed or couch of convenient height, the pelvis should be slightly raised on an unyielding pillow so as to bring the lower fundus of the bladder in a line with the urethral orifice; the head and shoulders should be supported by pillows, and the legs separated and somewhat flexed. Chloroform may, or may not, be administered. Civiale and Sir B. Brodie were both averse to its anæsthetic influence, alleging that the feelings of the patient are a safe guide in two essential matters—as to whether any injury is being inflicted on the bladder, and whether the operative proceeding is continued beyond what the bladder and constitution are capable of enduring. But, assuming a due manipulative skill in using the lithotrite, the irritable state of the bladder, and a nervous, restless state of the patient, in many cases, will as often render the influence of chloroform an invaluable or indispensable adjunct in performing lithotrity. The bladder is first emptied, and then injected with tepid water until it contains from about five to seven ounces of fluid, in order that its cavity shall be sufficiently distended to remove the mucous membrane from the blades of the lithotrite in seeking the stone, and to make room for crushing without injuring the bladder by splintering. In old cases of stone, the bladder may be so thickened and irritable as to eject a few spoonfuls of fluid; then the injection must be repeated very slowly and gradually, pausing occasionally, until the bladder becomes accustomed to the increasing distension. Some lithotritists, as Sir W. Fergusson and Sir H. Thompson, dispense with injection, as being unnecessary or prejudicial, and allow the urine to be retained instead. But on no account, without sufficient dilatation of the bladder, should the operation be proceeded with. Then the Surgeon, standing on the right side of the patient, as the most convenient position, introduces the warmed and oiled lithotrite cautiously along the urethra. The abrupt curve of this instrument, unlike the arched curve of the catheter, and resembling that of a sound, must be remembered as soon as the instrument reaches the curved portion of the uretha. By depressing the handle slowly down to a right angle with the perineum, the end of the lithotrite is brought into the direction of the canal under the pubic arch, and thence passed gently into the bladder. A slight rotatory movement with the instrument will always indicate when it has entered the bladder.

Seizure of the stone may be effected in either of two ways: by making it *fall* into the blades of the lithotrite, or by *searching* for it in a certain manner.

Sir B. Brodie recommends that the instrument should be raised, the blades opened, and that the convex extremity of the under or female blade should be rested against the lower fundus of the bladder, and gently pressed down, so as to make a conical *depression* in this situation; into which the stone falls by its own weight, or by a slight shake or jerk of the instrument with the hand. Similarly, Mr. Skey gives a smart blow with the open hand against the pelvis of the patient —a *coup*, he says, which will succeed again and again in making the stone fall into the grasp of the lithotrite. The male branch is pushed forwards to seize the stone. This manœuvre may have to be repeated several times before the stone is securely caught; the female branch remaining stationary, while the male branch is slid a little up and down alternately, until the stone is seized. Civiale recommends another method, in principle, as Sir H. Thompson observes, the reverse of the preceding. By position of the patient, the centre of the bladder and space beneath it are selected as the area of operation; *no depression* is made; contact between the walls of the bladder and the instrument is, as much as possible, avoided. The instrument is applied to the stone in the situation which it naturally takes, and the operator carefully avoids moving it, or any movements of concussion whatever, however slight.

Fig. 890.



The *situation* of the stone is often ascertained in *passing* the lithotrite; then, the blades are inclined slightly away from the side on which the stone lies, carrying the instrument backwards also towards the posterior wall of the bladder, while the male blade is slowly withdrawn, not to impinge on the neck of the bladder. By turning the opened lithotrite over towards the stone, and slowly closing the blades, the stone will almost certainly be seized. (Fig. 890; showing also Thompson's lithotrite in action.) Most frequently the stone will be caught on the right side of the floor of the bladder. If no stone be felt on entering the bladder, its cavity is *explored;* first, without altering the axis of the shaft of the instrument from its central or vertical position, by simply inclining the open blades to the right side, and then to the left side; finding no stone, secondly, depress the handle of the instrument about half an inch, thereby raising the open blades slightly from the floor of the pelvis to a horizontal plane, and turn them to the right and left. In completing each of these movements, the blades are closed to seize the stone. These five positions—vertical, right and left incline, right and left horizontal—will explore the bladder fully,—middle, right, and left, and will thus almost certainly find any stone of moderate size in a healthy bladder. If the prostate be enlarged, and the stone possibly lodged in a depression behind it, or if the stone be small or a fragment only, the blades may be reversed or turned downwards, and the handle raised, when it will often be found and secured with ease. To overcome the difficulty of prostatic enlargement, a modified form of lithotrite should be used; the curve of the instrument is made shorter and more abrupt, thus to mount over the upward projection of the prostate, especially if the middle lobe be enlarged, and the shaft is longer by two or three inches, on account of the elongation of the urethra; this twofold construction of the instrument corresponding to that of the prostatic catheter. It will be desirable also to elevate the pelvis, so that the stone shall fall back towards the posterior wall of the bladder, and thus further aid the manipulation of seizure.

The object of this method is strictly to avoid giving any jerk to the instrument or to the bladder; and by barely coming in *contact* with its interior, no pain or contraction of the bladder is provoked. The same object was sought to be attained by the other method, simply by *not moving* the instrument in the bladder for the purpose of exploring to ascertain the situation of the stone; the instrument being rested, and somewhat depressed, in the lower fundus of the bladder, to make the stone fall into its blades.

Coulson seems to combine *both* these methods in using the lithotrite: a slow twirling revolution of the instrument on its own axis, between the thumb and finger, without changing its central direction; and at the same time, a gently sliding motion of the male branch backwards and forwards to the extent of half or three-quarters of an inch—thus gently raking or traversing the floor of the bladder on either side successively.

Of these three methods of using the lithotrite, I prefer the latter.

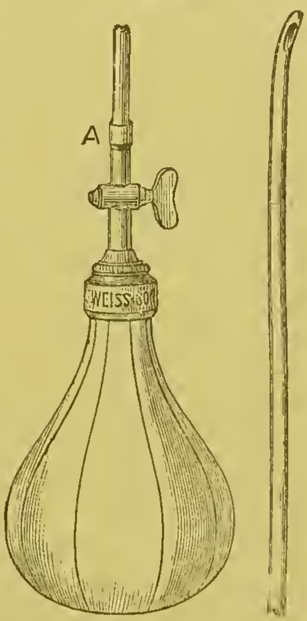
Crushing the Stone.—When once firmly fixed between the blades of the lithotrite, the stone is to be crushed into fragments. It is raised to the centre of the bladder, so that the mucous membrane shall not be injured by the splintering of the stone. Crushing may first be attempted by pressure with the hand alone—if the old instrument be used—without the action of the screw. The female branch is held firmly by the left hand, applied to the square portion; the circular projection immediately behind is embraced between the index and middle fingers of the right hand, hooked on to it and used as a point of resistance; the expanded extremity or wheel of the male branch rests in the palm of the same hand turned upwards and forwards. In this position, by strongly and repeatedly contracting the fingers towards the palm, the male branch is slowly and cautiously driven forwards on the stone, which is distinctly felt to break down. A small stone may thus be easily crushed. When this manipulation fails, the screw must be brought into action. Still holding the female branch firmly with the left hand, the handle of the screw is held between the thumb and fingers of the right hand, and the screw worked gradually from left to right, thus propelling the male branch forwards on the stone. If the rack-and-key lithotrite be used, the handle is held between the fingers of the right hand, backwards, as in drawing a cork with a corkscrew; and worked also by a number of short and sharp turns of the wrist. But the screw-acting lithotrite, as already explained, surpasses either of these instruments.

In either mode of crushing, by hand-pressure or screw-pressure, the male branch must be sent home into the female branch, so that the blades come together. This object is known to be obtained by observing that the entire length of the rack or screw passes down the lithotrite. Then the instrument can be safely withdrawn.

The fragments must be got out of the bladder as soon as possible, but not by a prolonged use of the instrument; lest in removing one source of irritation and inflammation, another be substituted. The crushing should not be repeated, unless the stone is small and friable, and can easily be reduced at once. This first sitting should be short, not exceeding five minutes.

Detritus can be removed amounting to a considerable quantity, and containing some not insignificant fragments. For this purpose, the bladder should be washed out with tepid water, injected through a large-sized and large-eyed double-current catheter. Clover's lithotritic injection-apparatus consists of a series of such catheters, with an india-rubber bottle, the nozzle of which fits the opening in the stem of the instrument. By repeating the injection three or four times, the fluid drawn off at last ceases to contain any detritus. This was Civiale's practice. But the elastic suction bottle, with stop-cock and catheter (Fig. 891)—as also devised by Mr. Clover—answers sometimes more effectually. Generally, however, it is unnecessary to wash out the bladder.

Fig. 891.



After-Treatment.—The patient should lie in bed, recumbent, for twenty-four hours, and not be allowed to stand or stoop forward in passing water, lest fragments might fall against or lodge on the neck of the bladder, greatly increasing the risk of irritation. Diluent drinks will promote the discharge of the detritus. In elderly persons with enlarged prostate, the discharge of fragments is impeded, and Sir B. Brodie recommends that the bladder should be washed out daily.

Subsequent sittings will be required to crush the fragments. Intervals of from three days to a week should elapse; when the operation may perhaps be prolonged to ten minutes at a time, as the bladder becomes accustomed to the instrument, or its irritability subsides with the gradual removal of the calculus. Generally from three to six sittings must be allowed, before all the fragments can be safely crushed.

In performing these after-crushings, Civiale's lithotrite with no slit in the female blade, is very serviceable for breaking down and removing fragments; the instrument being withdrawn charged with more than detritus. Fragments of rather large size may thus be extracted safely through the urethra. Having seized a fragment, the size of which may be estimated by observing the separation of the blades as indicated by the length of screw exposed at the handle of the instrument, the fragment is drawn to the neck of the bladder; when by a sort of slight pulling jerk with the instrument, the practicability of easily extracting it through the urethra can be ascertained. The bladder is washed out, to remove smaller particles. This procedure of fragment-extraction I have seen practised by Sir W. Fergusson. It is preferable, however, to crush all fragments, and allow the powdered detritus to escape per urethram, according to the method of Sir H. Thompson.

A *final* exploration of the bladder is made to determine the complete removal of every fragment; any one remaining portion would form the nucleus of a recurrent calculus. Civiale's method of exploration consists in sounding the bladder, with the patient recumbent, while the urine or tepid-water injection is flowing away; whereby the contraction of the bladder may bring any fragment more surely within the grasp of the instrument. Should this procedure fail, a small lithoclast is introduced and rotated slowly in the bladder, while the fluid passes out through the central channel of the instrument, the blades being opened to catch the fragment. Unless there be an encysted bladder, or an enlarged prostate, this method of exploration usually proves successful. Otherwise, the persistence of symptoms will indicate the retention of a fragment.

Certain *Difficulties* are liable to occur in the performance of lithotrity. They may be sufficiently anticipated and overcome by due attention to the directions given respecting the operation. Excessive Sensibility and Irritability of the Bladder, Enlargement of the Prostate, and the Impaction of angular fragments of Stone in the Urethra, may thus severally be managed. But the latter difficulty is noticed more particularly under Calculus in the Urethra. Encysted Calculus—a stone lodged in a sacculus of the bladder—presents a specially difficult complication in lithotrity, no less than in lithotomy, as with regard to seizing the stone; but in the former operation, the after-treatment may also be complicated by the impaction of a fragment in the sacculus, a condition which led to a fatal termination in a case treated by Sir B. Brodie.

Dangers of Lithotrity.—These are referable to the state of the bladder and kidneys, induced by the operation.

Hæmorrhage happens, sometimes, to an inconvenient amount for the free working of the instrument; though rarely to a dangerous extent. In the 115 cases operated on by Sir B. Brodie, he did not meet a single example of serious loss of blood from the urinary organs. It was, however, so copious as to necessitate immediate recourse to lithotomy, in a case operated on by Mr. Key; and a patient at the Hôtel Dieu, in 1832, died of hæmorrhage from the bladder.

Cystitis, acute, or more frequently chronic, ensues in some cases. In 184 cases of lithotrity by Sir H. Thompson, with twelve deaths, three were due to cystitis or pyelitis. This is usually the consequence of rough or prolonged lithotrity; but it may also arise from pre-existing prostatic or vesical disease, or from the retention of a fragment. The latter is sometimes associated with an enlarged prostate, behind which the fragment lodges; but the want of expulsion commonly depends on an atonic state of the bladder. Hence, any *débris* should be washed out by injection, in aid of the treatment for cystitis.

Nephritis, acute or chronic, of one or both kidneys, is not unfrequently a consequence of lithotrity. In the twelve deaths already referred to, no less than seven resulted from this cause.

Atony of the bladder occurs chiefly in old persons. The patient enjoys too quiet a state of the bladder after operation, the urine being retained with ease for several hours, owing to the loss of expulsive power. Chronic cystitis is very apt to supervene from retention of urine, in this deceitfully tolerant state of the bladder.

Spasmodic retention of urine somtimes follows the operation, and it occurs mostly in combination with an atonic state of the bladder. Both are most frequent in old persons with enlargement of the prostate. The treatment of the spasmodic retention consists in giving a warm bath and then a full dose of opium. In either case, the urine must be drawn off with a large-sized catheter, rather than allow any accumulation in the bladder.

Retention from the impaction of coagula or a fragment in the neck of the bladder must be treated by catheterization.

Suppression of urine, with coma, is an occasional consequence of the operation, and probably depends on some previously existing latent disease of the kidneys.

The *constitutional disturbances* incident to lithotrity may be comprised under rigors and febrile attacks, including pyæmic infection. *Rigors* not unfrequently set in immediately after the operation, especially after the first sitting, and last perhaps for some hours, terminating in perspiration. This attack is most common and severe when the operation has been prolonged, or the urethra overstretched, and not at all in proportion to the amount of pain. A full dose of opium, or a tumbler of warm brandy-and-water, as Sir B. Brodie recommended, are the best remedies; the patient lying in bed and wrapped in a blanket. Irritative *fever* may ensue, which rapidly assumes a typhoid character; the pulse rising in frequency to beyond what can be distinctly counted, and becoming proportionately feeble and irregular, with a dry, hot skin, and dry, harsh, brown tongue. Commencing perhaps with rigors, and passing off with sweating in a few days, the fever sometimes assumes an intermittent or a remittent character. But this attack is more surely fatal than the most severe rigors. *Pyæmia* occasionally supervenes, probably in connection with suppuration as the result of damage done to the bladder. Of the twelve deaths in Thompson's series of cases, two only were due to pyæmia. Pre-existing disease of the kidneys, attended with albuminous urine, always tends to induce these unfavourable or fatal constitutional consequences of lithotrity.

Their treatment mainly comprises the administration of opium and stimulants, with tonics—especially quinine—judiciously regulated.

Lithotrity in Children is attended with certain difficulties, which, as objections to this mode of operation at an early period of life, should not be overlooked. The small size of the urethra, and irritability of the bladder, are unfavourable to the free working of the lithotrite; while the neck of the bladder being very dilatable, it allows the impaction of fragments, even of some size. Small and soft stones are most suitable for the operation; and it has been practised occasionally, and with success, by Civiale, Fergusson, and other Surgeons, both in male and female children. But the great success of lithotomy in young subjects has brought that operation into far more established repute.

Results of Lithotrity, and as compared with Lithotomy.—Unquestionably the accumulating results of experience in lithotrity lead to the conclusion that a far larger proportion of cases can fairly be submitted to this method of treatment than was formerly supposed, instead of to lithotomy. When first practised in this country, the results of Sir B. Brodie's 115 cases showed a mortality of somewhat less than 1 in 12½; whereas the mortality of lithotomy is about 1 in 7, or even as high as 1 in 4½. Civiale's cases of lithotrity in one year—1862—amounted to 45, about his annual average. Of these, 8 were partially cured; and the operation was successful in all the remaining 37 but 1. The same distinguished lithotritist states that his total mortality in 591 operations was 14 deaths, or only 1 in 42·21. But this general result has been much criticized. Sir H. Thompson's cases having been more clearly recorded ("Med. Chir-Trans.," 1870), they afford trustworthy evidence of the relative mortality. Out of 184 consecutive cases of lithotrity in the adult, the deaths, reckoning every kind of casualty following the operation, were 12; but, omitting 5 cases resulting from previous disease of the bladder or kidneys, and thus leaving 7 deaths from operation, the mortality is reduced to only 4 per cent. Taking, however, the total of 500 cases of operation for stone in the bladder of the adult male,—as including the entire experience of the same operator up to January, 1877, we have the following results:—in 422 cases of lithotrity, 32 deaths, or 1 in 13; 78 cases of lithotomy, 29 deaths, or 1 in 2¾ cases; in total 500 cases, 61 deaths, or 1 in 8½ cases. The mortality of 122 cases of lithotrity in the hands of Mr. Crichton is about the same; being only 8 deaths, or less than 1 in 15. Sir W. Fergusson's experience comprises 271 cases of stone, of which number 217 were in adults; 110 were submitted to lithotomy, with a mortality of 33; whereas of 109 treated by lithotrity, only 12 died. Mr. Charles Hawkins has collected the results of all the cases of stone in the bladder admitted into the London Hospitals (excepting the Hospital for Stone), in the years 1862–63. The total number of patients was 177, comprising 86 children and 91 adults; of the whole number it would appear that only 32 were treated by lithotrity, while 139 underwent lithotomy—the remaining 6 cases not having been submitted to either operation. Considering the relative mortality of the two operations—so highly in favour of lithotrity—the small proportion of cases submitted to this operation would not seem judicious. At the Royal Free Hospital, it is true, the seven cases of stone in the two years all underwent lithotomy; but, then, they were all cases in children.

Selection of Operation—Lithotomy or Lithotrity.—The practical importance of a judicious selection of cases for either operation is well enforced by Civiale's statistical results. Thus,—in a total number of 838 cases of stone in the bladder, during a period of twenty years,—of the last 332 cases, 241 were lithotritized, leaving 91 which were considered unfit for that operation. Of the 91 cases, 28 were lithotomized, and in 8 others the two operations were combined; making a total of

36 cases subjected to lithotomy; of which Civiale lost 18, or exactly one-half.

The *conditions* which determine the fitness or applicability of lithotrity are:—(1) The state of the urinary organs, and of the bladder and kidneys in particular; (2) the general health of the patient, and as connected with age; (3) the nature of the calculus—as to size, density, shape, situation, and number.

When the bladder is healthy, and the kidneys free from disease, especially with regard to albuminous urine; the general health not deteriorated, and the stone small and friable; all the conditions concur in favour of lithotrity. The opposite conditions are, of course, unfavourable in a greater or lesser degree.

(1.) The conditions of the *urinary organs* relate to the bladder, kidneys, prostate, and urethra. As more or less unfavourable may be mentioned—an irritable or inflammatory state or tendency of the bladder, or an atonic state, or an hypertrophied bladder of diminished capacity. The latter state is not unfrequently associated with extreme irritability of the bladder, thus further contracting its cavity. Chronic cystitis, and especially of a purulent character, is a more unfavourable condition for operation than acute cystitis; which is also comparatively rare. But the significance of cystitis in relation to lithotrity depends very much upon whether the former be the cause or the effect of calculous formation. A stone consequent on cystitis is usually phosphatic, and being therefore soft and friable, it yields readily to the lithotrite. Diseases of the kidneys of a nephritic or degenerative character, attended with morbid states of the urine, are specially unfavourable. Hence, casts of the uriniferous tubes or blood in the urine, and the appearance of albumen to any amount, as persistent albuminuria, contraindicate the performance of lithotrity. Enlargement of the prostate is in *itself* only a mechanical objection to the operation; the stone often being lodged in a depression behind the enlarged gland, and not easily accessible to the lithotrite. Enlargement of the middle lobe more especially diminishes the capacity of the bladder, deepens its floor, and tends to conceal the stone in a cavity behind the gland. But an enlarged state of the prostate is often associated with an unhealthy state of the bladder, and occurs mostly in advanced life. Tumours in the bladder may offer considerable mechanical difficulty to lithotrity; but, according to Civiale's experience, the operation will be justifiable when the tumour is small, not very sensitive, nor liable to bleed, and the stone small and friable so that the completion of lithotrity is not likely to be prolonged by an unusual number of sittings. Stricture of the urethra, or an irritable state of the passage, will obstruct the introduction of the lithotrite and retard the discharge of detritus.

(2.) The conditions of the *general health* which are unfavourable for lithotrity cannot be clearly defined; they comprise chiefly a deranged state of the digestive organs, with loss of flesh and strength, nervous depression, and recurring febrile attacks. But in the 184 cases operated on by Sir H. Thompson, "many" of the patients were of "very feeble health and constitution."

Age is significant, in its relation to the accompanying state of the bladder and the health of the patient. In *children*, the diameter of the urethra is small; the antero-posterior diameter of the bladder is short; the organ is irritable, and its neck is very dilatable, a peculiarity which favours the impaction of the fragments; while the indocility of the child is a great difficulty in performing lithotrity, especially when repeated sittings are necessary. This latter difficulty can be overcome by chloroform; but the undeveloped condition of the genito-urinary organs before the age of puberty, renders the operation neither an easy nor a safe one. On the other hand, lithotomy is singularly successful. Nevertheless, if lithotrity diminishes the mortality in adults, it should, as Mr. Coulson observes, have a still greater influence in reducing the comparative mortality when applied to children—in whom the urinary organs are in a healthy condition—and because the number of deaths in adults, after crushing the stone, is greatly increased by the state of the urinary organs at that period of life. In *advanced periods of life* and old age, the irritable state of the genito-urinary organs forbids lithotrity. Exceptional cases of successful results have been met with; Segalas having lithotritized fourteen octogenarians, without losing one; and twenty-seven septuagenarians, with the loss of only two. Of Sir H. Thompson's 184 cases, the mean age was no less than sixty-one years; forty-six were seventy years and upwards; the oldest was eighty-four years; whereas only three were below thirty years, and the youngest was twenty-two years old. Lithotomy, on the other hand, is also very fatal in aged persons, although very successful in children.

(3.) The *calculus* itself has an important influence with relation to lithotrity, more than to lithotomy. A *large* stone is unfavourable for crushing, owing to the number of fragments in the bladder and the continued discharge of detritus through the urethra, and the necessity for a more repeated performance of the operation. The bladder should be proportionately healthy, a condition not often coexisting with a large stone. From Sir H. Thompson's large experience, it appears that a stone about the size of a *date* or *small chestnut*, and corresponding to somewhat less than an *ounce* in weight, is always suitable for lithotrity; all stones of an ounce weight and upwards being reserved for lithotomy. A stone of this size and weight may be easily discovered by sounding. Lithotrity has never proved fatal, when the stone was no larger than a small nut; but the rate of mortality rises with the increasing size of the stone, above that of a small chestnut. A *hard* stone yields sharp, angular fragments, very irritating to the bladder. A large and also hard stone may be said to contra-indicate lithotrity. But a soft or friable stone, even of large size, is not an unfavourable kind of calculus. Hence, the chemical nature of the calculus has some relation to lithotrity. Certain uric acid calculi which ring when struck with the sound, and oxalate of lime or mulberry calculus, are not readily crushed; whereas phosphatic calculi are easily broken down. The different consistence of the two latter kinds of calculi, in their relation to lithotrity, is, however, a consideration more than counterbalanced by the state of the urinary organs; in the oxalic acid diathesis, these organs being comparatively healthy; in regard to phosphatic calculi, equally unhealthy.

The remaining peculiarities connected with stone in the bladder present mechanical difficulties chiefly, as relating to the selection of the operation—lithotrity or lithotomy. Thus, the *irregular shape* of a stone offers a difficulty in seizing it with the lithotrite. But similar difficulty is experienced in seizing with the lithotomy-forceps, and there is the additional difficulty of extraction. The *situation* of a stone may render it inaccessible; as when lodged in a pit behind an enlarged prostate, above the pubes, or encysted anywhere in the walls of the bladder. It may then be almost equally hard to get at in either operation. A *single* stone is more suited than several calculi to the performance of lithotrity, and of lithotomy also. But the time necessary for the operative procedure of crushing must be taken into account. The presence of several calculi is not unfavourable for the operation of lithotrity, provided only they be small and soft. Civiale operated with success in a case where the bladder contained forty calculi.

The *chemical composition* of calculi submitted to lithotrity has varied; all kinds of calculi having been crushed, but perhaps chiefly those of uric acid and the urates. Thus, of Sir H. Thompson's cases, 122 were uric acid and the urates; sixteen were mixed; forty phosphatic; four oxalate of lime; one pure phosphate of lime; and one cystic oxide.

Lithotomy after Lithotrity.—The propriety of submitting a patient to the double risk of two operations, either of which may be of serious consequence, and which are performed almost in succession, can be sanctioned only by two orders of facts: that the one operation—lithotrity—has given rise to symptoms which render it apparently impossible to complete this procedure, by repeated sittings, without perilling the patient's life; and that the other operation—lithotomy—offers, therefore, the only means of relief, and with less comparative danger. The unfavourable symptoms after lithotrity may relate to the state of the bladder, excessive irritability or contraction forbidding a second use of the lithotrite, especially if, in addition, the stone be of large size and hard consistence, which would necessitate an unusual number of sittings; or, constitutional symptoms of a dangerous character may have been induced, the use of the lithotrite having provoked some pre-existing organic disease, of the kidney in particular. Under either circumstances, lithotrity should not be repeated, and recourse may be had to lithotomy with advantage.

The *results* of lithotomy as a resource after lithotrity have, on the whole, been encouraging. Of twenty-eight cases by Civiale, nineteen recovered, and nine died. Souberbielle thus operated in twelve cases, with ten recoveries; the remaining two deaths showing a mortality of one in six, or a not higher proportion than the average death-rate of certain series of lithotomy cases without previous lithotrity.

Recurrence of Stone.—After lithotrity, the return of calculus in the bladder is far more frequent than after lithotomy. In Civiale's practice, this has happened about once in every ten cases. Of thirty-six patients on whom he performed lithotrity in 1860, ten had been previously operated on, and stone had returned. But of Sir H. Thompson's 184 cases, a second operation for recurrence was performed in only thirteen cases. In no instance, however, was an operation of lithotrity completed by lithotomy.

Recurrence must arise from some fragment having remained in the bladder, which formed the nucleus of another calculus. Hence the practical importance of carefully searching the bladder at the last; the final exploration or sounding, to which I have already alluded. If a small fragment can escape detection in such practised hands as Civiale's, less-experienced lithotritists should be far more guarded in completing a case.

Irritability of the bladder, remaining for a long time, is a not uncommon sequel of lithotrity, itself successful. This never occurs after lithotomy; the bladder having been relieved of the stone, as the source of irritation, recovers its tone completely.

Treatment.—Whether after lithotrity or lithotomy, a secondary calculus must be removed. Which kind of operation should be repeated—crushing or extraction—must be determined by the conditions already mentioned with regard to the selection of these operative procedures. Secondary lithotomy may be performed through the track of the former wound, care being taken to avoid the rectum, which is somewhat drawn up and adherent to the membranous urethra and prostate; but the perineum may present no condensation of the textures, such as would render the operation more difficult, either in making the incisions or extracting the stone. Even a third operation has been performed on the same patient, and with success. Right lateral lithotomy may be resorted to, as Liston suggested, provided the Surgeon be ambidextrous. The median operation also is generally an available resource in these cases, the stone probably being of small size.

Prostatic, and Urethral, Calculi are more conveniently noticed in connection with Diseases of the Prostate Gland, and of the Urethra.

Calculus in the Female.—Stone in the bladder is not of common occurrence in women, though not very rare. In 146 cases of stone operated on at St. Thomas's Hospital, during a period of twenty-three years, South states that 144 were males, and only two females, giving a proportion of 1 female to 72 males. This is greatly below the average. Crosse, at the Norwich Hospital, found the proportion to be 1 female to 19 males. In France the average was higher—1 to 22. But in Italy, Civiale finds the average to be 1 to 18; which may probably be taken to represent the general average. Coulson puts the proportion, among those who are submitted to operation, at about 1 female to 20 males. The probability is that stone forms more frequently than it is found, in the female bladder. This seems owing to the peculiar anatomical conditions of the urethra, which facilitate the escape of a small calculus. The urethra is short, almost straight, of large size, and readily dilatable, without any natural contractions in the canal; and there is no prostate gland at the neck of the bladder. Thence, a stone may form in the bladder, but more easily escape through the urethra.

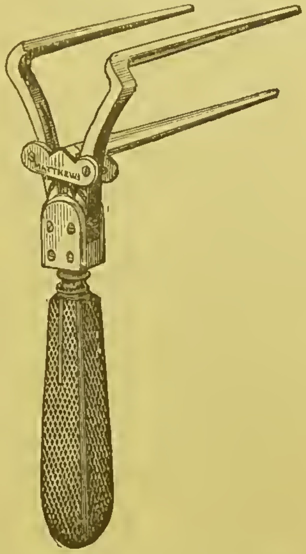
Symptoms.—In addition to the usual symptoms of stone in the male bladder, and the sure sign afforded by sounding, two special symptoms occur in the female. These are, bearing-down pains and pains along the urethra, and incontinence of urine,—a tendency to constant dribbling or wetting. Irritability of the bladder, from any of its various causes, or a vascular urethral tumour, may give rise to similar symptoms; but sounding will determine the diagnosis.

The consequences of persistent calculus in the female are sometimes remarkable; it may be discharged through the vagina, by an ulcerative communication through the bladder and the vagina, forming a vesico-vaginal fistula; or the stone may impede the descent of the fœtal head in birth, as a rare cause of difficult parturition. I once saw an instance of this kind in the Royal Free Hospital; a woman died after child-birth, and a stone was found in the bladder, the size of a hen's egg, consisting of phosphate incrusted with carbonate of lime.

Treatment.—The various operative procedures for removing calculi from the female bladder, are of four kinds :—(1) Dilatation of the urethra; (2) Dilatation, with partial slitting up, of the urethra; (3) Lithotrity; (4) Lithotomy, practised in four different ways.

Dilatation of the urethra may be accomplished *rapidly* or *slowly;* the former method was recommended by Sir A. Cooper when the stone is *small*, and that dilatation should be accomplished in a few minutes,—the method proposed by Tolet; but that when the stone is *large*, it will be better to dilate slowly and gradually from day to day, until the requisite extension is accomplished,—the method suggested by Douglas. Rapid dilatation is not much more painful than the slower procedure; but, according to Dupuytren's experience, and at variance with that of Mr. Coulson, it is much more likely to be followed by *incontinence* of urine. Dilatation can be effected by various means; solid or flexible bougies, gum-elastic catheters, prepared sponge, or other tents; or by the cautious application of Matthews' female urethra dilator — a three-bladed instrument, worked by a screw at the handle (Fig. 892)—the speculum, or blunt gorget. After sufficient extension, a pair of forceps is introduced and the stone extracted. Stones of considerable size and weight have been thus removed from the female bladder; notably, in a case by Coulson, the calculus weighing four ounces, and without any incontinence having resulted. In one case I succeeded with forceps alone in extracting an oxalate of lime calculus, the size of an almond, which was impacted in the urethra of a young woman. The stone had been lodged there for some time, causing partial retention of urine; and when removed, its exposed surface was obviously "water-worn" by constant attrition of the stream of urine in micturition.

Fig. 892.



The *results* of urethral dilatation will enable the operator to more accurately estimate the relative merits of the rapid and the slow methods of this procedure; and the balance of evidence would appear to be not unfavourable to the former method. Thus, we find that in twenty-eight cases which Mr. Bryant collected from the records of Guy's Hospital, four only were followed by any incontinence of urine, but they were cases of slow dilatation; whereas the remaining great majority of twenty-four, without any resulting incontinence, had been submitted to rapid dilatation. Slow or gradual dilatation—in from twenty-four to forty-eight hours—has, however, yielded very safe results in the hands of Professor Humphrey, and when some of the stones were of large size. I suspect that the latter fact, as relating to the *extent* of the dilatation requisite, according to the size of the stone, would reconcile some of the apparent differences of result attributed to the rapidity or slowness with which the dilatation was conducted.

Dilatation, with *partial slitting-up* of the *urethra*, is applicable when the former method has been carried to the farthest extent consistent with safety, and yet the stone is too large for extraction without thus dividing the urethra. This method is described by Ambrose Paré, who saw the elder Collot perform the operation, but it was probably originated by Dubois. A grooved staff was introduced into the urethra, and on it a small incision was made vertically *upward*. Sir B. Brodie revived this operation, and divided the urethra directly upwards under the symphysis pubis. Dilatation was then made with Weiss's instruments, to a sufficient extent for the introduction of the forceps and extraction of the stone, downwards and outwards. The objection to the upward incision is that it necessitates extraction of the stone where the space is most restricted.

The *direction* of the incision has been varied by Surgeons: some cutting directly downwards—as recommended by Chelius; some obliquely downwards—as Le Dran proposed; and others sideways.

Double incision of the urethra, combined with dilatation, was proposed by Dionis; the urethral orifice being divided horizontally on both sides. In these operative procedures by urethral incision, the vagina is necessarily involved, when the incision is downwards, or even oblique. The probability of incontinence of urine resulting from urethral incision, rather than from dilatation alone, seems doubtful; Surgeons of great experience holding directly opposite opinions on this important issue. But after double incision in Dionis's cases, incontinence followed in three out of every four patients thus operated on.

Lithotrity is preferable to either of the above methods—urethral dilatation, or with incision combined—when the stone is of *large* size. This operation is far more easily performed in the female than in the male; and it is frequently more successful in its results; both these advantages having reference to the peculiar anatomical conditions of the urethral passage, already mentioned. But a double depression may be found, as Civiale observes, in the posterior and inferior wall of the bladder,—an anterior and a posterior receptacle, formed by the projection of the neck of the uterus; and in either cavity search must then be made for the calculus or fragments. In old women a depression exists behind the internal opening of the urethra, wherein some difficulty may be experienced in using the lithotrite. After-treatment in the female is, however, less liable to be attended with any difficulty by the retention of fragments in the bladder, or from impaction in the urethra; detritus and fragments of some size are readily discharged through the large and easily dilated urethra, facilitated also by the shorter and straighter course of the passage.

Lithotomy is also more readily performed than in the male, and it may be done in either of *four* ways.

The patient is placed under chloroform, and tied up in the position as for the operation in males; and a grooved staff is introduced into the urethra, which is hooked up perpendicularly under the symphysis pubis. A common bistoury, lithotomy-forceps, and scoop are the only other instruments required.

(1.) *Urethral* lithotomy is nothing more than incision of the urethra, carried up the passage, so as to divide also the *neck* of the bladder. Dilatation is then made sufficiently to allow of the completion of the operation by extraction. A straight staff having been introduced into the bladder, its groove is directed downwards and outwards towards the ramus of the ischium, and the urethra divided obliquely downwards with a probe-pointed bistoury. This incision often intersects a small portion of the anterior wall of the vagina. Chelius recommends a vertical incision directly downwards, thus dividing also the corresponding wall of the vagina. A bilateral section of the urethra has also been performed. Liston notched the neck of the bladder on both sides towards each ramus of the pubes, and then dilated for a few minutes until the finger could pass into its cavity.

The *lateral* operation, similar to that in the male, and practised originally by Frère Jaques, was revived by Dr. Buchanan, of Glasgow. A grooved staff, curved or straight, having been passed into the bladder, an incision is made on the inner side of the left nympha, from a point about half an inch above the urinary meatus, and carried downwards and outwards, parallel with the rami of the pubis and ischium. By touches with the knife between the rami and vagina, which is drawn inwards and protected by the left forefinger, the staff is reached just in front of the neck of the bladder; then, lodging the point of the knife in the groove, a slight urethral incision is made, inclining the blade downwards and outwards, and dividing the neck of the bladder. The opening can be enlarged with the finger sufficiently to introduce the forceps and extract the stone.

This operation has yielded successful results; the wound healing rapidly, and the patient having the power to retain her urine. Lateral lithotomy seems to be specially suitable in female *children.*

(2.) *Direct* lithotomy might be performed, as suggested by Celsus. This method of "cutting on the gripe," in women, consists in passing the fingers into the vagina, in order to press the stone forwards against the neck of the bladder, and then making a transverse incision directly on the stone between the urethra and symphysis pubis. Lisfranc endeavoured to revive this method in 1823; but it has justly fallen into disuse.

(3.) *Vagino*-vesical lithotomy consists simply in making an incision through the vagina into the bladder, and thence extracting the calculus. A curved staff is used so that its convexity shall appear in the anterior wall of the vagina, while the posterior wall is depressed with a blunt gorget or a speculum. In this method of operation the urethra is avoided, and afterwards a female catheter is introduced through this passage into the bladder, and the edges of the vaginal incision are brought together by suture, as originally suggested by M. Coste, and first practised by Dr. Marion Sims. Immediate closure of the incision was first adopted in this country by Mr. J. R. Lane. Vagino-vesical lithotomy is suitable for the extraction of large calculi, and in adults. Vidal has thus operated in thirty cases without any death, and Velpeau also testifies to the freedom from danger. There is generally no hæmorrhage, nor subsequent peritonitis; but vesico-vaginal fistula is a common result, unless the precaution be taken of closing the incision at the time of operation.

Incontinence of urine is apt to follow all these operations of lithotomy, although the last-named method is least liable to this result.

(4.) *Supra-pubic* lithotomy has been recommended in the female, as an occasional resource; when the stone is of very large size, or the pubic arch contracted, or perhaps both these complications are associated.

CHAPTER LXII.

DISEASES OF THE BLADDER.

The Bladder is subject to Diseases, not differing in their nature from those of other organs; but which present modifications in their pathology and symptoms, and thence in their treatment. Thus, inflammation, known as Cystitis, acute and chronic, and various Morbid Growths or Tumours, may affect the bladder. But the Malformations of this organ are peculiar; and its Functional Conditions are special in their character; such as frequent micturition, retention of urine, incontinence or involuntary escape of urine, and engorgement with overflow of urine. These conditions may also be symptomatic of the diseases referred to, which involve structural alterations in the bladder.

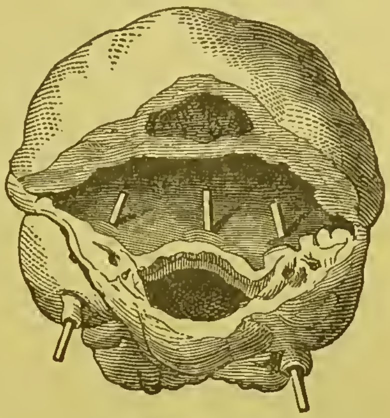
Cystitis—*Acute.—Structural Condition.*—The seat of inflammation affecting the bladder is primarily the mucous membrane; occasionally, in consequence of the intensity or duration of the process, the subcellular tissue and the muscular or middle coat may secondarily become involved; but this inflammation never occurs in the middle and outer or peritoneal investment, independently of the mucous membrane. The portion of this membrane situated about the neck of the bladder, is most commonly and severely affected; extending thence to the whole of the lining membrane. After death, the membrane is found injected and reddened in specks and patches; or it may have assumed a greenish slate colour, or a chocolate tint, when the inflammatory condition has been of some duration. Occasionally, lymph-effusion takes place on the surface of the mucous membrane; forming shreds or patches of lymph, or even a false membrane slightly adherent to the whole interior of the bladder. Very rarely, this membrane has been known to cause retention of urine, necessitating puncture of the bladder; and I remember the late Dr. Robert Knox to have told me that, in Edinburgh, he had seen a membranous vesical cast of this kind drawn out of the bladder by supra-pubic puncture. In the female, it is sometimes thrown off entire.

Symptoms.—The essential symptoms of acute cystitis are—severe pain and sense of aching weight in the region of the bladder above the pubes, extending down the urethra into the perineum and down the thighs; this pain is accompanied by a frequent, urgent, and soon intolerable desire to pass the urine, which is expelled at short intervals, in small quantities, by spasmodic straining efforts. These symptoms are those of simple irritability of the bladder, in an extreme degree. But the contracted bladder, forming a small, round, and firm tumour, is exceedingly painful on slight pressure over the pubes, or when touched or tilted with the finger through the rectum; and the character of the urine also—high coloured and acid, mixed with mucus or pus, and perhaps tinged with blood—indicates an inflamed state of the vesical mucous membrane. The symptomatic inflammatory fever or constitutional disorder is often severe.

Cystitis usually commences suddenly and runs a rapid course; or it may supervene on the chronic form of the disease.

Causes.—Acute cystitis is commonly the consequence of an extension of inflammation from adjacent parts; most frequently from the urethral mucous membrane, by gonorrhœal inflammation extending backwards to the neck of the bladder, in retrocedent gonorrhœa; or more severe inflammation may have extended from the prostate, the rectum, or the kidneys. Injuries comprise—blows and pelvic fractures, operations of lithotrity, prolonged catheterism, injections, and lithotomy; in the female, prolonged and instrumental labours; also the mechanical irritation of calculus; the chemical action of cantharides and of some mineral poisons, and strong diuretics; or the action of the urine itself, retained and decomposed, as in stricture and prostatic enlargement. The disease arises also sometimes from gout, or from exposure to cold.

Fig. 893.*



Terminations.— Resolution; or the disease may subside into the chronic form; suppuration in the wall of the bladder (Fig. 893), leading to peritonitis, or between the bladder and rectum, followed by urinary infiltration in the cellular tissue of the pelvis or of the perineum; ulceration, or gangrene of the mucous membrane, in the worst cases.

Treatment.—Remedial measures consist in derivation, diluents and alkalies to render the urine unirritating, and the influence of opium. Thus, perfect rest in the recumbent position will relieve the bladder of the whole weight of the upward column of blood; and this derivative effect may be aided by leeches to the perineum, and warm fomentations to the abdomen. Laxative aperients, such as castor oil, preceded by a dose of calomel at the beginning, will also derive from the bladder and keep the bowels free from irritation. Diluent drinks, such as barley-water, should be liberally allowed; and the citrate or nitrate of potash largely diluted. Opium may be advantageously administered in the form of enemata or suppository, thus to allay the distressing vesical irritability; while the continued influence of opium, taken internally, tends to subdue pain and inflammation. Belladonna, hyoscyamus, and conium have also some reputed efficacy, whether as administered by the mouth or per rectum.

If cystitis be the consequence of *retrocedent gonorrhœa*, the return of urethral discharge should be solicited by warm fomentations to the penis, or wrapping it in a poultice. When the urine is acid, and its sediment yellowish and not coherent, but purulent, Sir B. Brodie recommends a pill of calomel two grains, with half a grain of opium, to be taken twice or three times a day. When the urine is alkaline, and deposits a small quantity of brownish adhesive mucus, the same author advises the vinum colchici to be given in fifteen minum doses, thrice daily for three or four successive days.

Cystitis resulting from *cantharides* locally or internally absorbed, comes on usually within two to four hours after the dose; the symptoms soon reach their maximum of intensity, and subside in from six to twelve hours. Bicarbonate of potash and full doses of hyoscyamus should be given every half-hour for three or four hours, and perfect rest enjoined. If a blister has been the cause, it must be removed at once, and the surface thoroughly sponged free of every particle of cantharides.

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* Roy. Coll. Surg. Mus., 1994B. (John Hilton.)

Chronic cystitis.—This form of the disease presents two varieties: inflammation of the vesical mucous membrane, with very slightly increased secretion, or with an abundant secretion of muco-purulent matter. The one condition is *simple* chronic cystitis; the other is known as *catarrh* of the bladder, or cystorrhœa. In both varieties, especially the catarrhal, the mucous membrane has become thickened, velvety, and of a dark colour; the vessels being injected or congested, and the muscular coat somewhat hypertrophied.

Symptoms.—The same symptoms are exhibited in both states of chronic inflammation; and modified only in degree from those of acute inflammation. But chronic catarrh of the bladder is distinguished by the discharge of thick, tenacious, greyish muco-purulent matter in the urine, in greater or less abundance, and which gradually subsides to the bottom of the vessel in which it is collected. Under the urine, it appears as a semi-transparent, whitish, tenacious jelly, something like parboiled white of egg; and on pouring off the urine, it hangs slightly adherent to the vessel, and then slides down suddenly in a lump; or it can be poured from the vessel in long coils, resembling macaroni. This mucous deposit may be tinged with blood, or present white streaks of phosphate of lime. The urine itself becomes brownish, ammoniacal, and fœtid. A typhoid febrile condition accompanies this advanced state of the disease; the pulse becoming extremely rapid and feeble, the tongue dry and brown, with great prostration and cerebral oppression.

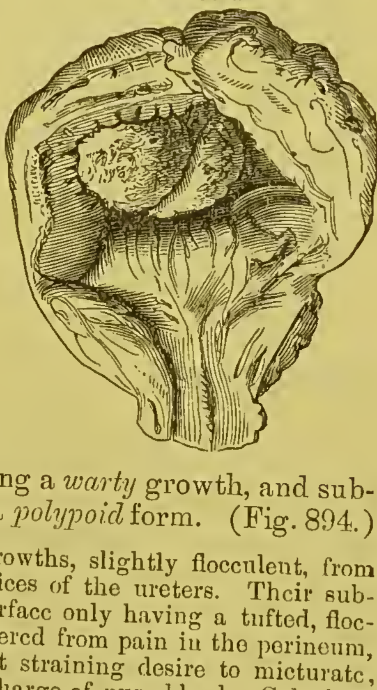
Causes.—Acute cystitis may subside into the chronic or persistent form of inflammation. But chronic cystitis often arises independently, from any cause of long-continued irritation of the bladder;—from calculi and other foreign bodies, or tumours in the bladder; or from the retention and decomposition of urine; as in stricture of the urethra, or enlargement of the prostate, or in spinal paralysis. The latter disease is not only a cause of retention—it also induces an inflammatory state of the vesical mucous membrane by impaired innervation.

Treatment.—The same plan of treatment is appropriate as in acute cystitis, only modified in degree. It comprises derivation from the bladder, correction of an irritant state of the urine, and the influence of opium to allay pain and vesical irritability. Counter-irritation may be employed by means of a mustard poultice or iodine-paint, applied to the supra-pubic region; or a blistering liquid of cantharidine in chloroform, to the perineum, when the neck of the bladder, more particularly, is affected. I rarely have recourse to any such derivative treatment. But the abundant discharge of mucus or muco-purulent matter and the alkaline state of the urine, which especially characterize chronic *catarrhal* inflammation of the bladder, render certain special treatment necessary; to arrest the secretion from the mucous membrane and to correct the state of the urine. Pareira brava, a concentrated decoction, uva ursi, or the infusion of buchu, given with the mineral acids, are more or less efficacious; I much prefer the concentrated decoction of pareira with diluted nitro-muriatic acid in ten or fifteen minim doses. The acid is more suitable when the urine is itself alkaline, than when it subsequently becomes so by admixture with alkaline mucus in the bladder. Benzoic acid also renders alkaline urine acid, and I have found gallic acid useful in arresting the secretion of ropy mucus. Injections are highly serviceable, when no acute symptoms are present. They may be sedative, as decoction of poppies, in quantities of not more than two ounces, and retained for half a minute once a day; or astringent injections, as diluted nitric acid, ten minims gradually increased to twenty in two ounces of water, and allowed to remain for a few minutes. Sir H. Thompson speaks highly of the acetate of lead, beginning with one-sixth of a grain to the ounce of distilled water; and next to this agent, the nitrate of silver, commencing with one grain to eight ounces of water, gradually increased up to one grain to the ounce of diluent. Carbolic acid, in the proportion of only two or three drops to half a pint of water, as an injection, is said to have a corrective influence on the urine, when fœtid. But I prefer to remove the muco-purulent secretion, as it collects from time to time, by simply washing out the bladder with tepid water, by means of the bladder-injecting syringe and large double-current catheter; throwing in the injection gently, and to not more than three or four ounces, over the interior of the sensitive and irritable bladder. Then the free surface can be treated with a sedative or astringent solution, more effectually. By these measures, coupled with tonics and a generous diet, to support the dread exhaustion of chronic cystitis, we may succeed in arresting the progress of the disease to a fatal issue. In conjunction with this course of treatment, the removal of any cause in operation must obviously be a primary consideration. Hence, the treatment for stone or other foreign body in the bladder, or perchance a tumour in this organ; and the various causes of retention,—from stricture, enlarged prostate, or paralysis.

Tumours of the Bladder.—These diseases comprise—(1) Fibrous growth, of a warty or of a polypoid character; (2) Villous or vascular growths; (3) Cancer; encephaloid, scirrhus, epithelial, colloid.

Fibrous growth springs from the mucous membrane and submucous tissue, and consists of their elemental structures. It commences in the form of a circumscribed elevation of the mucous membrane, resembling a *warty* growth, and subsequently enlarges, protrudes, and assumes a *polypoid* form. (Fig. 894.)

Fig. 894.*



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* Roy. Coll. Surg. Mus., 2006. Two spongy growths, slightly flocculent, from the mucous membrane of the bladder, near the orifices of the ureters. Their substance consists of solid medullary cancer; their surface only having a tufted, flocculent character. The patient, for some years, suffered from pain in the perineum, anus, and sometimes in the glans penis; frequent straining desire to micturate, bloody urine, mixed with mucus, or occasional discharge of pure blood. Calculous concretions were also passed, but no stone was ever detected on sounding the bladder. (Hunterian.)

The *symptoms* are those arising from any cause of pain and irritation, with obstruction to micturition; and there is also the presence of a foreign body in the bladder. Simulating stone, careful sounding to discover the situation and form of the growth may show distinctive characters. Phosphatic deposit encrusting the growth may, however, still mislead as to its true nature; but the fixed position, and impossibility of passing a sound around the tumour, free of the bladder, will aid the question of diagnosis. Yet, the resemblance to an *encysted* calculus is even then, I am sure, sufficiently perplexing to perhaps baffle the most careful exploration.

FIG. 895.

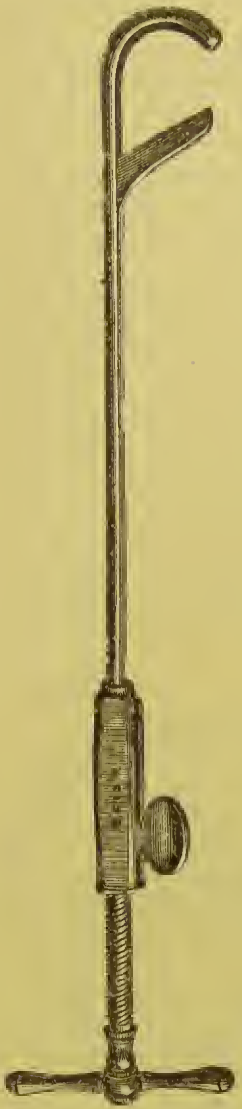
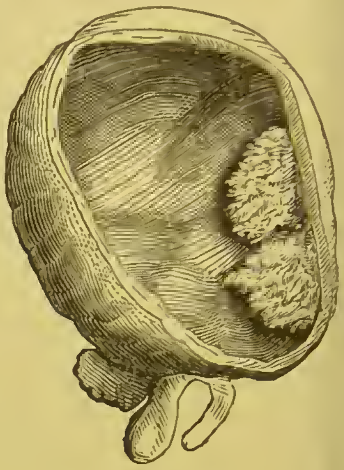


FIG. 896.*



This species of growth is most common in children and young persons. The absence of blood in the urine, or in any notable quantity, distinguishes warty or polypoid growth from both the remaining species—villous growth and cancer.

The *treatment* is palliative, to allay pain and vesical irritability, with the use of a catheter when necessary. Polypus of the bladder has been removed by Aveling's polyptrite (Fig. 895), ligature, or the knife. In one case, Civiale succeeded with a lithotrite; in another, Warner with a ligature, after dilating the urethra in a female, the tumour being the size of an egg; and in fifteen cases collected by Dr. Senftleben, ligature or the knife was used, but in all, except one instance, with fatal results. He, therefore, suggests supra-pubic cystotomy for the removal of vesical polypus.

Villous growth springs also from the mucous and submucous tissues, and consists of cellular elements and large looped capillaries. It presents in the form of innumerable fine villous processes or tufts, which branch off from the base in every direction. (Fig. 896.) Floating in water, this growth appears as a soft, flocculent body, about the size of a large marble when fully developed. Several such tumours may coexist, giving to the interior of the bladder a studded, villous appearance. The structural identity of the villi with those of the chorion in a healthy state is remarkable.

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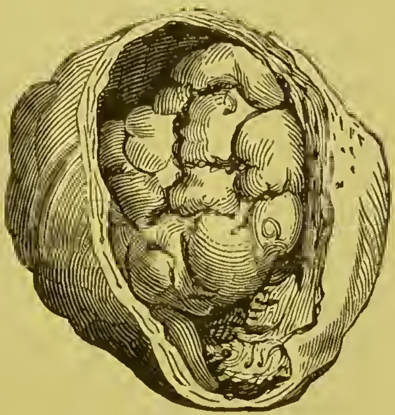
* Roy. Coll. Surg. Mus., 2005. Two vascular, tufted, shreddy, and flocculent growths, springing from the mucous membrane of the bladder, near the orifice of the right ureter; and a smaller one from the membrane, an inch above the prostate gland. The larger growths are of a spheroidal form, about three-quarters of an inch in diameter, and attached by narrow bases; the branching filaments of which they are chiefly composed, and which had a bright-red colour, float freely within the cavity of the bladder. The patient, a man aged sixty-five, had lead palsy for sixteen years. About five months before death, he was troubled with a constant desire to pass water, micturating every half-hour, and discharging apparently fluid blood. This attack continued for a month; and about a fortnight before he died, the symptoms returned, and proved fatal from exhaustion and increased paralytic symptoms. (Sir E. Home.)

The *symptoms* are not peculiar, either with regard to obstruction or the presence of a foreign body in the bladder. But the pain and vesical irritability are much aggravated; and the abundant, oft-recurring draining hæmorrhage, or *bloody urine*, distinguishes this species of growth from polypus. Shreds of the tumour are also apt to appear in the urine, which examined by the microscope, will confirm the diagnosis.

The *treatment* is palliative, as for polypus. Astringent injections may perhaps be used, as weak solutions of acetate of lead or nitrate of silver; and astringents taken internally, as gallic acid, may prove serviceable in arresting the tendency to hæmorrhage. Tonics, especially iron and quinine, with a nutritious diet, will be requisite to support the patient under the exhaustion resulting from long-continued pain, irritability of the bladder, and hæmorrhage. The introduction of any instrument must be avoided as much as possible; sounding is less effective in the diagnosis of a growth so soft and flocculent; catheterism aggravates the pain and irritation, and may provoke bleeding; while the removal of a villous growth would be equally hazardous and ineffectual.

Cancer of the bladder is more common than the last-named species of growth. It may be primary, commencing in the bladder; or secondary, extending from the prostate, the rectum, or the uterus. The species is most frequently *encephaloid* (Fig. 897), and usually so when originating in the bladder, always of this kind when spreading from the prostate; *scirrhus*, when spreading from the rectum or the uterus, or *epithelial* cancer from the latter organ. *Colloid* is more rare; but in post-mortem examination I have met with this species of cancer occupying the whole interior of the bladder, as a semi-transparent, greenish-yellow, trembling mass of jelly; as if the organ were fully distended with urine. Similar colloid deposits were found in the uterus and rectum, and in most of the abdominal viscera.

FIG. 897.*



Symptoms.—The pain of cancer in the bladder is very severe, but scarcely ever lancinating; and is referred to the lower part of the belly, to the loins, hips, thighs, and perineum. Vesical irritability is so active, that the urine is ejected every few minutes; and when ulceration of the mucous membrane ensues, it is expelled with sweating agony. The semen also may be emitted, and the contents of the bowel evacuated, or the bowel itself protruded, during the writhing effort to strain off the last few drops of urine. Profuse, gushing *hæmorrhage*, or *bloody urine* and of an alkaline, fœtid, purulent character; with perhaps the appearance of cancer-cells in the urine; are tolerably distinctive of cancer-growth in the bladder. Examination with the finger, per rectum, may discover a tumour in, or involving, the base of the bladder. But the presence of a solid *tumour* in the situation of this organ at the lower part of the abdomen, is characteristic of cancer; excepting when a non-malignant growth has attained to such size as to occupy the bladder,—a rare event. Then the diagnosis will turn on the general severity of the bladder-symptoms, aided, perhaps, by the appearance of the cancerous structural elements in the urine. But it may be difficult to distinguish cancer-cells from rudimentary forms of vesical epithelium, unless a mass of infiltrated papillæ be discharged. Age and sex help to guide the diagnosis. Thus, scirrhus most frequently occurs in men, and between forty-five and sixty years of age. Constitutional symptoms, with glandular enlargements in the iliac regions, may supervene in an advanced stage of the disease; but the peculiar cancerous cachexia is even then not well marked. The patient's general health and aspect is that of a person worn down simply from pain, sleeplessness, and loss of blood. *Calculus* sometimes coexists with cancer, especially encephaloid; and the presence of a stone may be detected by sounding, which at the same time discovers a tumour; if the mass bleeds readily in gently exploring with the instrument, it will probably be encephaloid.

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* Roy. Coll. Surg. Mus., 2003. A medullary cancer, of spheroidal shape, occupying nearly the whole cavity of the bladder, between four and five inches in diameter; the surface is lobulated and slightly fissured. The muscular coat of the bladder is thickened, but the portion of mucous membrane not covered by the growth appeared healthy. From an old man; with signs of the tumour, of long duration. The deep "inguinal glands" presented a very hard tumour, some weeks before death. (L. Foakes.)

Treatment.—Palliative measures only have any effect; comprising opiates, administered internally and sometimes by injection, tonics, and supporting diet. The disease is invariably fatal.

TUBERCLE of the bladder is a very rare affection; probably never occurring unassociated with tubercular deposit in other parts of the body, and of the urinary system especially; the kidneys and prostate, in particular, being similarly affected. In women, it has been known to have followed primary disease in the uterus.

The *symptoms* are not peculiar, and the diagnosis is chiefly negative. Great pain, and extreme irritability of the bladder; with the absence of obstruction to micturition, and of a calculus or other foreign body, of hæmorrhage in any quantity, and of any perceptible tumour; together with the presence of tuberculosis, and progressive emaciation. These circumstances, taken in conjunction with the patient's age, usually early or middle adult life, will indicate the nature of this disease.

The interior of the bladder presents different appearances, according to the stage of the disease. Tubercular deposit may be found, in the form of small granulations, seated in the mucous coat of the bladder, and more often at the base or neck of the organ. These points may have coalesced, but they continue in a chronic state for a long period. In an advanced stage, the tubercular matter softens, and the mucous membrane gives way, forming an ulcer of variable size, but having a ragged undermined margin, infiltrated with deposit. Tubercular matter is now discharged in the urine, which can be recognized with the eye, or detected with the aid of the microscope; thus at length declaring the nature of the disease. Ultimately, the extent of ulceration may be such as to destroy nearly the whole of the mucous membrane; and then a very large, ragged ulcer is found after death.

Treatment must have reference to the constitutional disease—tuberculosis, and the remedies for chronic cystitis.

Hæmaturia.—Blood in the urine, or simply bloody urine, is a *symptom* only of disease in some part of the urinary organs. Varying in quantity, from a small proportion discoverable only by the microscope, to an amount constituting the greater portion of the fluid passed, the admixture of blood and urine may be estimated by corresponding differences in the colour of the urine. When blood is present in small quantity, the urine has a brownish or smoky tint; and deposits a reddish-brown sediment on standing. In large quantity, the urine has a dark-brown, muddy colour, like chocolate; and deposits a red sediment, adhering to the bottom of the vessel. Intermediate tints are met with, according to the admixture of blood. Heat coagulates the blood into a brownish-grey deposit, leaving a clear fluid above; and microscopic examination exhibits the characteristic red blood-discs. These tests, especially the latter, will show the presence of blood in the urine, and thus distinguish hæmaturia from simply dark reddish-coloured urine, due to other causes—bile, rhubarb, and other colouring matters, or to mere concentration of the urinary secretion.

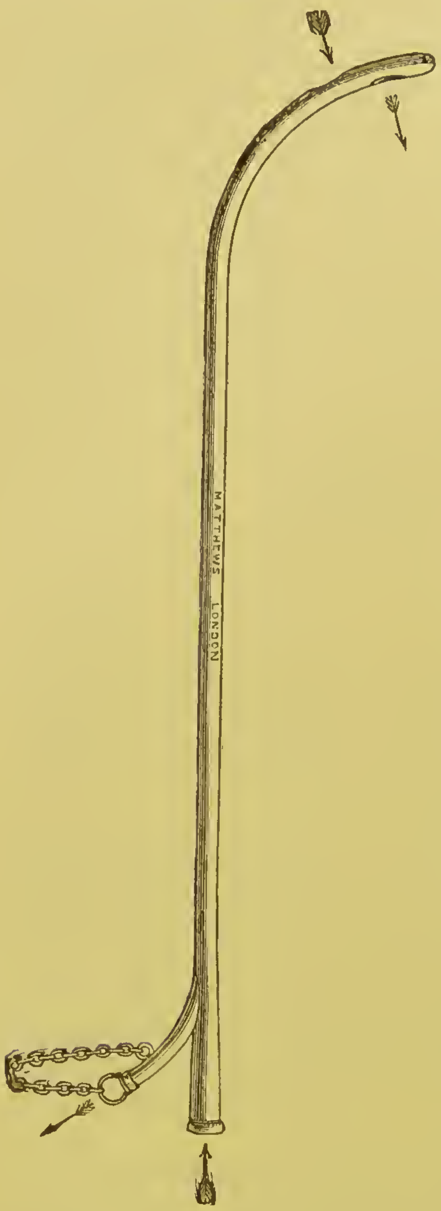
The *source* of the blood in hæmaturia, and thence the seat of the disease, may be any one or more of the following parts:—(1) the kidney; (2) the pelvis of the kidney; (3) the ureter; (4) the bladder; (5) the prostate; (6) the urethra.

Causes.—Diseases of the kidney, acute and chronic; injury, as blows, strains, etc.; calculus in any part of the urinary tract—the kidney, ureter, bladder, prostate, or urethra; violent diuretics, as turpentine or cantharides; cystitis, occasionally; villous tumour of the bladder; the hæmorrhagic diathesis; certain blood-diseases, as fever or purpura; stricture of the urethra; urethral chancre; chordee; local application of mechanical and chemical agents.

The *diagnosis* of the *source* of blood in the urine is the same as of these causative conditions. But the general ground of distinction is this:—when hæmaturia is renal, the urine will be uniformly mixed with the blood; when it is vesical or prostatic, the first portion of urine that passes, or that is drawn off by the catheter, will be pale and less bloody than the last, and at the termination of the stream, pure blood only may escape; when proceeding from the urethra, the blood may be mixed, but more often unmixed, with urine, passed also in the form of worm-like clots or casts of the urethral canal, and independently of micturition.

Treatment must always have reference to the cause of hæmaturia—the disease whence the blood emanates. The general remedial measures are rest, the recumbent position, and astringents. Gallic acid in particular, sulphuric acid, acetate of lead combined with opium, or Ruspini's styptic, may severally be administered internally. In vesical hæmorrhage, oil of turpentine is specially efficacious; in doses of from ten to fifteen drops, suspended in mucilage. Cold may be applied to the hypogastrium, perineum, or within the rectum by injection. I am in favour of ice-cold water enemata. The management of the blood collected in the bladder has given rise to a diversity of opinion. It is recommended that the coagulum should be broken up and withdrawn, by the introduction of a full-sized catheter to which a syringe is then applied, the blood being thus gradually extracted by suction; or the bladder can be washed out by means of a large-eyed double-current catheter (Fig. 898), as in a case which I attended with Dr. Crisp, where I thus removed broken-down clot, with some ammoniacal urine, to the amount of a quart. Generally, this disturbance of the clot would seem to be unnecessary and prejudicial. Its removal is apt to reopen the vessels and renew the hæmorrhage, while the solvent action of the urine will most safely and effectually bring away the blood. Opium may succeed in controlling the urgent desire to micturate; and when absolutely necessary to relieve retention of urine, surgical interference can be resorted to.

Fig. 898.



Malformations.—Congenital aberrations of development in regard to the Bladder are not commonly met with; the misery any such condition entails necessarily precluding the unhappy individual from society. Probably, however, such cases are more numerous than was formerly supposed; as, since surgical attention has been directed to their relief, persons thus afflicted present themselves more frequently at Hospitals and in private practice.

Malformations of the bladder are of three kinds:—(1) absence of the organ, with certain abnormal deviations of the ureters; (*a*) their direct communication with the urethra, (*b*) with the rectum, (*c*) with the vagina; (2) coexistence of two or more bladders; (3) extroversion of the bladder, with corresponding deficiency of the anterior wall of the abdomen, exposing the posterior wall of the organ as a prominent projection.

Extroversion of the bladder demands more particular notice, this malformation being susceptible of relief.

With absence of the abdominal wall over the bladder, the pubic symphysis is sometimes absent also. The posterior wall and base of the organ are then pushed forward by the abdominal viscera, and form a prominence; the mucous membrane having a red, vascular appearance, and showing the orifices of the two ureters, whence the urine trickling down, perpetually moistens the surface. From beneath the lower margin, a short imperfect penis depends, which is flattened, as if cleft in the middle line into the urethra. At the root of the penis, a rudimentary prostate exists, the ducts opening into the angle between the bladder and pubes. A pouch of integument below represents the scrotum, and contains the testes, with usually some hernial protrusion of the bowels beneath the extroverted bladder. Both sexes are liable to this malformation, but it occurs more commonly in the male. In the female, the generative function is not necessarily wanting. But, in both sexes, the extroverted mucous membrane is very sensitive and readily bleeds; while the continual distillation of urine, producing excoriation of the parts beneath, and pervading the patient with a constant odour of stale and decomposing urine, renders his life a misery to himself and intolerable to others about him.

Treatment.—Mechanical contrivances have been made with the view of forming an artificial abdominal wall over the bladder to catch the urine as it flows; thus preventing excoriation and the urinous odour. An india-rubber bag may be fastened over the bladder for this purpose; but great nicety of fit and capability of adjustment to the various positions of the body are requisite elements in any such contrivance.

Plastic operations have also been devised with the view of restoring the deficient abdominal wall, and thus closing in, or as it were completing, the bladder. An ingenious operation of this kind was originally performed by M. Adolphe Richard, in October, 1853; it was founded upon one performed by M. Nélaton for a lesser degree of deformity—simple epispadias—in the early part of 1852. Subsequently, in 1859, Pancoast, of Philadelphia, introduced the use of two reversed flaps, taken from the sides of the bladder, and turned with the skin surface towards the bladder. In the same year, Dr. Daniel Ayres, of New York, operated in two cases on the same principle; and the skin at the margin of the exposed bladder was dissected up and brought together by sutures over the raw surface of the reflected flap. Into this country, Mr. Timothy Holmes was the first to introduce an important modification of the operation,—reversed and superimposed flaps taken from the *groins*, at the sides of the bladder; whereby a better supply of nourishment is provided, from the recurrent branches of the common femoral artery, for primary union to take place. Mr. John Wood has completed the operation, in all its details, and has been the most successful operator.

The *operation* now consists of two stages: the first, to effect the closure of the upper part of the bladder; the second, after an interval of about a month, to close in the lower part, and to form a prepuce and complete the urethra. Closure of the bladder is accomplished by reflecting two triangular flaps of skin, one on each side of the exposed bladder, with their bases downwards, and attached to the skin of the groin at Poupart's ligament. The apex of each flap meets the other at the median line above the extroverted bladder, so that the raw surfaces exposed by lifting them are continuous at that point. The inner edges of the flaps are made close up to the bladder, and are brought together in the median line, and united by interrupted wire sutures. The penis may then be fastened down to the scrotum by a silver wire suture passed through the frænum, to allow a free escape of the urine. The angles of the groin and umbilical incisions are then to be united by wire sutures. Completion of the urethra and the formation of a prepuce—according to Wood's operation—"consists in raising the whole front of the scrotum, together with the skin covering the lower side of the penis—going deep enough to include the muscular layer of the *dartos*—so that these tissues form a sort of bridge of skin connected with the groin on both sides. This is then lifted over the penis, which the great extensibility of the parts permits easily to be done, and placed upon a bed or raw surface, prepared for its lodgment by turning down a collar or flap from the arched border of the bladder-covering above, and from the sides of the urethra and penis below, as far forward as the glans. A continuous thin wire suture holds the deeper or reversed flaps together, and a single line of interrupted sutures connects the transplanted scrotal structures to the border of the bladder-covering. The gap in the scrotal wall is afterwards easily closed in over the testicles by the great extensibility of the hinder part of the bag, which is left intact; the margins of the wound being brought together vertically by thickish wire sutures that will not easily cut out."

As to the *difficulties* of these plastic operations, Mr. Wood finds that in the first stage, or closure of the bladder, the chief difficulty arises from the hernia-like protrusion of the hinder wall of the exposed bladder by the action of the abdominal walls upon the contained viscera. In the second stage—that of forming the new prepuce and completing the urethra—the chief difficulty arises from the occurrence of erections in the imperfect penis, excited perhaps by irritation of the sutures; thus displacing the united parts, or rupturing the newly formed adhesions, before sufficiently firm to resist tension.

After-treatment.—The former difficulty referred to, is best obviated by *position* of the patient, after operation; a sitting posture, with the knees drawn up, tied together, and placed over a high bolster. This relaxes the abdominal and pelvic muscles connected with Poupart's ligament completely, and also allows the urine to drain off by gravitation from the raw and adhering surfaces. Erections are most effectually controlled by continued *cold applications*, as by irrigation or ice-bags.

Results of Operation.—Richard's case was unsuccessful, death ensuing, in nine days, from peritonitis. Ayres's two cases were both successful. So also was another by Mr. Michel, 1868; that of a male child, fourteen months old. But Mr. Wood records eight cases of operation ("Med.-Chir. Trans.," 1869), in none of which was there the slightest approach to peritonitis; and all recovered, except the first case, which terminated fatally, death however not resulting from the operation. The success of operation, in curing or relieving the malformation, has been variable; sometimes a perfect result, sometimes a complete failure, sometimes a greatly improved condition.

FUNCTIONAL MORBID CONDITIONS. — The bladder is subject to functional morbid conditions, which may, or may not, involve structural alterations in the organ.

These conditions of function comprise:—(1) Irritability of the bladder, with frequent micturition; (2) spasmodic action; (3) neuralgia; (4) paralysis; (5) atony; (6) incontinence or involuntary escape of urine; (7) engorgement of the bladder, and overflow of urine; (8) retention of urine.

The anatomical construction of the bladder has important relations to these various functional conditions of this organ. A recapitulation of its structure (p. 599) will tend to elucidate their pathology.

The urinary bladder is essentially a hollow expansion of mucous membrane, continuous with that of the ureters above and the urethra below; the function of this membranous bag being simply to receive and retain the urine, as secreted by the kidneys and conveyed by the ureters, until convenience may permit of its discharge through the urethral passage of exit, from time to time. Accordingly, the external aspect of this receptacle is closely surrounded with bands of muscular fibres—the unstriped variety—disposed, amid cellular tissue, in figure-of-eight spiral loops, running vertically, obliquely, and horizontally. These muscular bands are plentifully supplied with blood-vessels—the superior and inferior vesical arteries—with also some branches of the uterine arteries in the female—both of which are divisions of the internal iliac artery; they inosculate and issue in large plexuses of veins. The latter are situated chiefly at the neck, sides, and base of the bladder, and terminate in the internal iliac veins. Lymphatics accompany the veins in their course. Nerves are supplied, partly from the sacral plexus, itself derived from the spinal cord, and these nerves are also distributed on the base and neck of the bladder; but a large supply coming from the hypogastric plexus of the great sympathetic is distributed on the upper surface and remaining portion of the bladder, not supplied by the sacral plexus of nerves. The muscular bands, blood-vessels, lymphatics, nerves, and cellular tissue together form a second layer or coat, superimposed on the "mucous coat," in which the vessels and nerves ramify and terminate; while externally, this "muscular coat" is partially invested by a reflection of the peritoneum, forming the "peritoneal coat."

IRRITABILITY OF THE BLADDER.—This functional condition is denoted by *frequent micturition,* of a more or less painfully urgent character.

The healthy irritability or contractility of the bladder is the vital property of the *muscular bands,* in its middle coat. Stimulated by the urine accumulated in the bladder, they contract both vertically and transversely, and by their combined action—aided by the voluntary action of the abdominal muscular parietes compressing the viscera downwards on the bladder—the contents of the organ are expelled, as occasion may require. The pathological condition of undue or increased irritability is, therefore, immediately referable to the muscular or middle coat of the bladder; but the painfully urgent desire to evacuate its contents arises from a similar exalted sensibility of one or other systems of *nerves,* or may be referable to both.

Irritability of the bladder—thus a musculo-nervous functional condition of this organ—is itself a symptom only; yet it is one which has a wide-spread etiology, comprising both local and constitutional causes; the latter relating chiefly to morbid states of the blood, or of the nervous system, and connected frequently with various hygienic and social habits of life. Vesical irritability is, therefore, not merely a symptom which may be selected for the convenience of associating much valuable clinical experience pertaining to diseases, different in themselves; but, as a symptom, it may have also a valuable *etiological* significance, by leading to the discovery of latent disease in operation, in perchance some distant and previously unsuspected organ or part of the body; while the continued influence of any such disease, and thence its *prognosis*, may perhaps be determined by the persistence of the vesical irritability. Consequently, rational curative *treatment* can be brought to bear upon the disease, which has been thus indicated and estimated.

Causes.—The bladder has its nervous and vascular relations to surrounding organs, and to organs distant in the body—both in health and disease. This twofold relation to other organs, through the medium of the nervous and vascular systems, is the key to the etiology of irritability of the bladder. But the organ itself may be the seat of irritation, in disease of the bladder; or its contents may be the source of direct irritation, as by the presence of stone, blood, or morbid conditions of urine.

All the causative conditions of vesical irritability are conveniently arranged under two general heads :—

Local causes.—Diseases of surrounding organs which cluster around the bladder, may severally operate as causes of its irritability. The majority of these diseases affect the bladder through either its nervous or vascular relations with the organ diseased. But some apparently act *mechanically*, in reducing the *capacity* of the bladder as a receptacle for urine; by pressure from a tumour of the rectum or uterus, or by displacement of the latter organ. Diseases of the bladder itself may sometimes act mechanically in like manner; by hypertrophy or thickening of the wall of this organ, or by chronic enlargement of the prostate. In either way, the capacity of the bladder being diminished, while the quantity of urine secreted and conveyed into it continues undiminished, or is perchance increased, a more frequent discharge of urine is necessitated—a more frequent micturition, and thus the phenomenon of vesical irritability will be established. Other organic diseases of the bladder, as cancer, may operate in part mechanically; but more especially, by inducing an exalted state of the *vital* property of *irritability* or contractility in the muscular coat of the bladder. Cystitis, in the acute stage of inflammation, being unattended by any notable thickening of the bladder, would seem to have a similar influence. So also morbid contents of the bladder; as various conditions of the urine, the presence of blood or of a stone.

The various local diseases which operate as causes of vesical irritability may be enumerated in connection with the organs themselves, as follow:—(1.) Habitual constipation and Diseases of the Rectum; principally—hæmorrhoids, fissured anus, inflammation of the rectum, stricture, cancer, abscess about the rectum, and fistula in ano. (2.) Displacements and Diseases of the Uterus and Vagina; chiefly—prolapsus uteri or vaginæ, acute inflammation of the uterus, cancer, fibrous tumour. (3.) Stricture of the Urethra, organic, spasmodic, inflammatory, also phimosis. (4.) Diseases of the Prostate gland; chiefly—chronic enlargement, inflammation, cancer, and other tumours. (5.) Diseases of the Bladder; chiefly—hypertrophy, cystitis (acute and chronic), cancer, stone, hæmorrhage, hernia. Morbid conditions of the Urine, with Urinary Deposits, rank as local causes of irritability by their direct operation on the interior of the bladder; but, as pertaining to Urinary Pathology, they are included under the second general heading.

Constitutional causes.—This great class of causes embraces—(1) morbid conditions of the blood, (2) those of the nervous system.

Morbid conditions of the *Blood* result from perversions of the blood-forming processes; (*a*) by mal-assimilation, primarily in the process of digestion, or secondarily in that of nutrition; (*b*) by mal-excretion, through the kidneys, skin, or liver. Diseases of the *organs* severally concerned in these processes, gives rise to the consequent blood-conditions; and they, in their turn, are manifested by corresponding states of the urine and urinary deposits; the whole constituting Urinary Pathology. In relation to irritability of the bladder, the organic conditions are remote causes; the urinary conditions are direct or immediate causes; while the blood-vascular system is the medium of communication. The chief of the causative urinary conditions are—lithic acid and lithates, oxalates, and phosphates.

Morbid conditions of the *Nervous System* comprise diseases of the Nervous centres—brain, and spinal cord; and of the ganglionic centres of the sympathetic nervous system. Diseases of these central *organs*, and of organs generally, being severally connected through the nervous system, they may thence become causes of vesical irritability.

It thus appears that diseases of organs *distant* from the urinary bladder in the body are brought to bear upon this organ, through the agency of the nervous and vascular systems; just as *local* diseases generally operate, in like manner, upon it. Hence the wide-spread etiology of irritability of the bladder.

Treatment.—Remedial measures must of course have reference to any cause or causes in operation. The treatment of local causes will be found in the various sections of this work, as pertaining to Diseases of the Rectum, etc.; and the treatment of constitutional causes, both from a remedial and preventive point of view, is a large and special subject, which is considered, as relating to Urinary Diseases, and Deposits, at p. 646 of this volume.

Spasm of the Bladder.—This affection is said to be an involuntary, uncontrollable, and exceedingly painful contraction of the bladder, occurring from time to time; the cause usually being inflammation, stone, morbid growth, etc. Spasm, like irritability, is a symptom only, of which disease is the cause. I am disposed to regard both these symptoms as the same, but as differing in their degree of intensity; spasm representing excessive irritability, and an acutely painful urgency of micturition.

The *treatment* of this affection is that of cystitis, and the removal of any foreign body from the bladder.

Neuralgia.—Excessive sensibility of the neck of the bladder is an occasional affection; unaccompanied with any apparent disease discoverable during life or after death. This painful affection seems to arise more often from constitutional causes, resulting in a generally depressed state of the nervous system, and of the circulation; especially from chronic rheumatism, and the anæmia consequent on malarious poisoning. But vesical neuralgia may also proceed from rectal constipation, the irritation of sexual excesses, habitual masturbation, or other local causes. A correct diagnosis is very important, lest perchance stone in the bladder or some disease of the organ be mistaken for neuralgia; or the worse error be committed, of attributing a merely neuralgic affection to some such organic cause.

Treatment must be conducted on ordinary principles; the removal of any causative condition referred to, and the administration of anodynes, or their topical influence by suppositories, with tonics, a well-regulated diet and state of the bowels, change of air, and other hygienic resources. One of the worst cases I ever had, was in an old, enfeebled debauchee, subject to rheumatic attacks, and whose rectum was often loaded with the feculent matter of hard, undigested food. He became much relieved by removing this source of irritation.

PARALYSIS OF THE BLADDER.—This condition of the bladder signifies a loss or impairment of the contractile power of its muscular fibres, by failure of the nervous supply to this organ.

The paralysis may be partial or complete, and the usual cause is some lesion of the cerebral or spinal nervous centres. Thus, it occurs in connection with injury to the brain or spine; or from disease, as apoplexy, softening, or other structurally destructive disease. Sometimes the paralysis seems to be dependent on functional conditions,—as in hysteria; spinal debility induced by sexual excesses; reflex action from some adjacent source of irritation, as hæmorrhoids and after operations for their removal; the shock of injury; the result of fever; and the influence of certain medicinal agents, as belladonna, hyoscyamus.

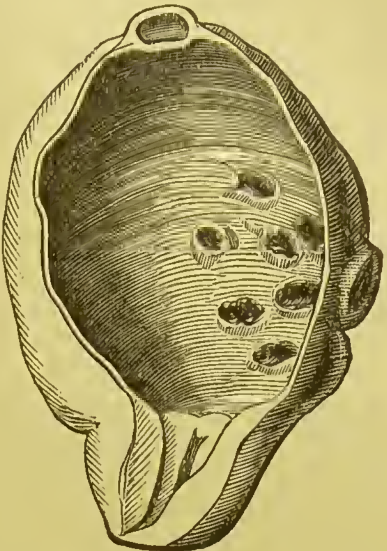
These two classes of causative conditions have each an important characteristic. The *functional* causes of paralysis of the bladder produce only a temporary effect; and the *structural* causes generally involve other parts—they are not restricted in their action to local paralysis of the bladder alone. Such limited paralysis of the whole organ, producing retention of urine, or of its neck only, producing incontinence, is extremely rare; it is usually not a paralytic condition, but simply atony from over-distension.

Treatment.—Palliative measures consists in emptying the bladder from time to time, and in the treatment of chronic cystitis consequent on the paralysis and retention of urine. The urine must be drawn off, two or three times a day, by means of a full-sized catheter. It should be used gently, the bladder having lost its sensibility to pain when injury is inflicted, and the urethra being often in a lax state. The stream of urine drawn off will be small, or even dribbling, owing to the bladder having lost its contractile power; propulsion depending on the action of the abdominal muscles alone, when not involved in the paralysis. Chronic cystitis should be treated principally by local means; injections of tepid water to wash out the bladder, followed by weak astringent injection. Curative measures must be directed to the restoration of innervation—the supply of nervous influence.

In chronic cases, not traumatic, strychnia, iron, arsenic, cantharides, and ergot of rye, may prove beneficial; while, of local agents, blistering, cold douches, and electricity are the most promising.

ATONY, FROM OVER-DISTENSION.— It is highly important to observe the distinction between this condition of the bladder and paralysis. Unlike the latter condition, atony always arises from some organic obstruction—stricture or enlarged prostate, mechanically impeding the evacuation of urine, or from long-continued retention; thus overcoming the contractile power of the bladder, instead of arising from any failure of this power. The resistance offered to the passage of urine, or by its accumulation, is simply greater than the expelling force. Hence, a portion remains behind after each act of micturition, and this residual urine having amounted to twenty or even thirty ounces in quantity, it begins to expand the neck of the bladder; leakage takes place, when strong expulsive force is exercised, or by relaxation of the sphincter during sleep. But the resistance prevails, and the contractile power is gradually more and more overcome by continued distension of the bladder; until the muscular fibres are overstretched, and the cavity of the organ becomes proportionately enlarged. The bladder is in a permanently atonic and enlarged condition. (Fig. 899.)

Fig. 899.[*]



Treatment.—Curative measures will consist in the removal of any cause of obstruction to the free passage of urine, and the prevention of its accumulation in the bladder. The urine should be regularly drawn off once or twice a day, in order to enable the muscular fibres to recover their normal condition of contraction and tone. A small, slow stream of urine will be procured, the contractile power of the bladder being overcome by distension. By this mechanical relief, a more or less completely successful result may be produced. At the same time, the tone may then be reinforced by medicinal treatment; chiefly, by the stimulants of nervous action, general and local, employed in paralysis. Injections of cold water into the bladder have a direct and marked beneficial effect.

Certain *modifications* of the function of *micturition* remain to be noticed.

Incontinence of Urine.—An involuntary escape of urine differs from frequent micturition, which is of a voluntary, although painfully urgent, character.

Incontinence may occur under two opposite conditions. In *children*, and only during sleep, when the voluntary power of retention is temporarily suspended, the bladder then emptying itself; in *adults* of all ages, from retention amounting to *over-distension*, a certain quantity of the urine then running off and leaving a quantity still retained,—an event which may happen during sleep or waking. An involuntary escape of urine, in the adult, always indicates a *distended*, not an empty, state of the bladder.

The *causes* of incontinence differ accordingly. In childhood and youth, it generally arises from debility, or intestinal irritation; sometimes from the evil habit of masturbation, or an acid state of the urine. In adult life, its causes are those of retention—paralysis affecting the bladder, atony from over-distension, stricture, enlarged prostate, cystitis, stone. In the *female*, incontinence is generally the result of some injury to the urethra, impairing or destroying the action of the sphincter; such as sloughing from pressure in difficult labour, from the application of instruments in delivery, or from over-dilatation of the urethra for the removal of stone in the bladder; but the incontinence is not unfrequently an hysterical affection.

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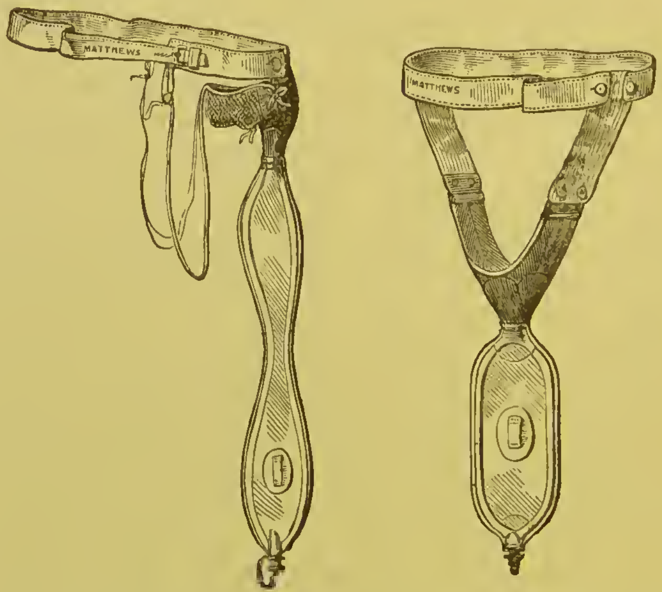
[*] St. Thomas's Hosp. Mus., BB. 10. Atrophy and dilatation of the bladder, to about four times its natural size, and extreme thinning of the walls of the cavity; sacculation, in the form of nine small pouches or sacculi, from the posterior and left sides of the bladder, and one from the fundus; no appearance of fasciculi. The middle lobe of the prostate is enlarged, in the form of an elevated ridge, at the neck of the bladder; thus altering the course of the prostatic urethra upwards, and obstructing the orifice.

The neck of the bladder is sometimes the seat of *structural* disease or malformation; occasionally, of disorganization resulting from injury, as from a kick or fall on the perineum, or the operation of lithotomy. The incontinence is then usually a *continual* dribbling, the urine running off from the bladder as fast as it arrives there from the kidneys. This condition, therefore, differs from both the ordinary modes of incontinence, in childhood or adult life. It differs also from frequent micturition, not only in its involuntary character, but in there being no distinct acts of micturition.

Treatment.—In *children.*—A general tonic plan of treatment is indicated, combined sometimes with sedatives. The vinum ferri is often beneficial, or the sesquichloride of iron, quinine, strychnia, or the tincture of cantharides, may be administered with advantage. Of course, the doses of these agents must be apportioned to the early period of life. Sir H. Thompson speaks highly of the extract of belladonna; commencing, according to the age of the patient, with the sixteenth to the eighth of a grain twice a day, and increasing the dose as far as it can be safely borne, when requisite. In extremely obstinate cases, he has succeeded by applying a solution of nitrate of silver, ten grains to the ounce, to the prostatic portions of the urethra and neck of the bladder. And in the female, this remedy is also easily applicable. The sacro-lumbar region may be subjected to the influence of a cold douche every morning, or to counter-irritation, occasionally, by blistering. Any source of intestinal irritation, as worms, must be removed; masturbation, if practised, should be prevented, if possible; and acidity of the urine corrected. Under this course of treatment, the child, who

FIG. 900.



previously had wetted his bed perhaps every night, may at length retain his water; care being taken not to allow the whole night to pass without seeing that the little patient's bladder is relieved voluntarily. With proper management, the child will, after puberty, generally outgrow the complaint.

In *adults.*—Catheterism, to relieve the distended bladder, is always the primary indication of treatment. Other remedial measures must have reference specially to the causes of incontinence. In cases of an incurable character, a urinal may be worn with great comfort. Various contrivances have been used, such as a gum-elastic bag on the inner side of the thigh, attached by a tube to the penis. (Fig. 900.)

Engorgement of the Bladder, and overflow of Urine.—The *regorgement* of the bladder, of French authors, consists in partial retention of urine, and occasional *overflow*, of quite an involuntary character. It depends on the mechanical obstruction of enlarged prostate; this body rising up at the neck of the bladder and forming a corresponding receptacle behind it, in which urine accumulates. When the fluid rises above the level of the enlarged prostate, an overflow takes place, leaving the bladder still engorged. This state of repletion and overflow is proportionate to the size and obstruction offered by the prostate.

The *treatment* by catheterism, as peculiar to enlarged prostate, will be described with that condition.

Retention of Urine.—This *absence* of micturition is considered in connection with Stricture of the Urethra.

CHAPTER LXIII.

DISEASES OF THE PROSTATE.

The Prostate Gland, surrounding the neck of the bladder and commencement of the urethra, is subject to certain Diseases: Inflammation or Prostatitis, acute and chronic; Hypertrophy or simple enlargement, in advanced age; Atrophy; Cancer; Cysts; Tubercle; Calculus.

These diseases, identical in their nature with the same diseases of other parts, require notice only in so far as they present symptoms peculiar to the prostate, and relative to the bladder; which accordingly modify the treatment.

Inflammation of the Prostate, or Prostatitis.—*Acute* prostatitis rarely occurs unconnected with inflammation of the bladder or of the urethra.

Symptoms.—A sensation of weight and fulness is experienced about the neck of the bladder, rectum, and perineum; frequent and painful micturition, the pain increasing towards the close of the act; with a constant straining desire to evacuate the bowel, and great pain in defæcation, the motions having a somewhat flattened form; while an enlarged and exquisitely tender state of the prostate is discovered by examination with the finger introduced into the rectum. The accompanying inflammatory fever is often very acute; commencing with rigors, and leading to a high degree of constitutional disturbance.

As the prostate enlarges, micturition becomes difficult, and total retention may ensue from the obstruction. An attempt to pass an ordinary catheter meets with some opposition, and produces great pain, when the instrument reaches the neck of the bladder.

Causes.—Prostatitis is usually a consequence of gonorrhœa, the urethral inflammation extending upwards to the prostate, or of stricture of the urethra, or of injury in the violent use of stricture or lithotrity instruments; or it results from the irritation of a calculus, strong injections, or cauterization of the prostatic urethra. Cold and damp to the perineum will also give rise to it, and especially in gouty or rheumatic subjects. As occasional causes may be mentioned—alcoholic drinks and inordinate sexual excitement, when, in either case, urethritis already exists, or hard riding on horseback. As an idiopathic inflammation it is very rare.

It terminates in the course of a few days, in resolution or in suppuration, or becomes *chronic* inflammation.

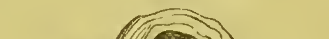
Treatment.—Local blood-letting from the perineum affords the greatest relief. Ten or twenty leeches should be applied, or cupping performed to the amount of six or eight ounces; followed by warm poppy-head fomentations and hip-baths. Pain is best relieved by opiate suppositories; as of pil. saponis co., five or ten grains. A free purgation, and subsequently gentle action of the bowels, with antimonial salines and low diet, constitute the remainder of the treatment. Retention of urine may yield under a full dose of opium, or necessitate the occasional use of the gum-elastic catheter. By promptly adopting these measures, the inflammation may subside, without suppuration; although there is always a liability to relapse, the prostate remaining enlarged and hardened for some time, with some difficulty or delay in the passage of the stream of urine.

Abscess of Prostate.—Suppuration is preceded by throbbing about the neck of the bladder or in the perineum; the rectal swelling becomes softer, and fluctuation may be perceptible; pus appears in the urine, when the abscess bursts into the urethra and discharges through that passage. Generally, the urethral opening soon closes; if it remains open it becomes a receptacle for urine, and induces abscess in the perineum, which bursting externally, forms a fistula in perineo. Sometimes, the abscess opens through the rectum, resulting in the establishment of urethro-rectal fistula; and occasionally it opens into the bladder. Not unfrequently, the abscess is burst by the introducduction of a catheter, in relieving the retention of urine caused by the enlarged gland; the matter being drawn off through the instrument. The quantity discharged may be considerable.

Peri-prostatic abscess occurs in not a few cases; the matter forming external to the prostate, and not within the capsule of the organ. Such abscess is of less serious import than prostatic abscess.

Treatment should be prompt and decided with the view of giving vent to any formation of matter. When, therefore, there is a tendency to perineal pointing, as indicated by brawny induration, without any fluctuation, an incision should at once be made in the middle line, about three-quarters of an inch anterior to the anus, and down to the matter; taking care to avoid the rectum. With this view, the fore-finger of the left hand should be passed into the bowel; a long, straight, and narrow, sharp-pointed bistoury used, and the edge be directed upwards. The depth to which the incision must be carried will be an inch and a half to two inches, and it is extended straight upwards in the raphé just sufficiently to give a fair patulous aperture. Relief is immediate. If no pus makes its appearance, the relief of tension and pain will be effected, and the matter may escape through the wound after poulticing for a few hours. Thus, then, communication with the urethra or rectum is prevented. Puncture through the rectum has been made occasionally, when fluctuation was distinctly felt in that situation. It may be desirable to draw off the urine, from time to time, by a well-curved gum-elastic catheter, or even to keep the bladder empty by retaining the instrument, if it can be tolerated; thus to prevent any accumulation of urine in the cavity of the abscess, which would be a source of continued suppuration. In passing the catheter, its point should be directed along the roof of the urethra, when the turn is made under the pubic arch; thus to avoid slipping into the cavity of the abscess, which would seem to have occurred in the following instructive case. (Fig. 901.) The specimen here figured represents the bladder and prostatic urethra laid open from behind; showing a large phosphatic calculus, having a median groove, as if from the constant passage of urine—a "water-worn" stone. The prostatic urethra communicates with a *large*, smooth-walled (abscess?) *cavity*, just above the prostate, between the fundus of the bladder and the vesiculæ seminales; and this cavity seems to have displaced the bladder upwards and forwards. The course of the urethra into the bladder is indicated by a rod. The patient, fifty-five years old, had inability to retain his urine, but constant desire to pass more; with pain in making the effort, and other signs of stone in the bladder. These symptoms increased in the course of seven years; but no stone could be detected by means of a sound, nor by the finger per rectum; both modes of examination having been repeatedly tried. Purulent urine supervened, and death from exhaustion. The failure of vesical exploration would appear to have been owing to the sound passing into the above cavity; and by displacement of the bladder upwards, the stone was beyond reach of the finger through the rectum.

Fig. 901.*



Peri-prostatic abscess must be treated in like manner, there being no practical distinction between it and prostatic abscess.

Chronic inflammation results in enlargement of the prostate; which is accompanied with frequent micturition, but a less forcible propulsion of urine than natural, followed perhaps by a drop or two of blood; usually also there is a gleety discharge, and the urine is milky and deposits more or less purulent matter on standing. Pain in sexual intercourse, and nocturnal emissions, are often experienced. These symptoms are much increased by riding on horseback or prolonged walking exercise, and by errors of diet. Examination with the finger per rectum will discover the prostatic enlargement.

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* Roy. Coll. Surg. Mus., 2029. (R. B. Walker.)

Treatment consists in counter-irritation to the perineum, and careful regulation of the digestive organs; the administration of iodide of potassium, tonics, especially iron and quinine, and a supporting diet. Nocturnal emissions are best overcome by the application of nitrate of silver to the prostatic urethra. By pursuing this course of treatment for a long period, a cure will generally be accomplished.

CHRONIC ENLARGEMENT, OR HYPERTROPHY, OF THE PROSTATE.—This prostatic affection is of common occurrence after the age of fifty-five to sixty years; but it never happens before the first-named period, and extreme old age seems to be less liable to it. Age and this prostatic enlargement are, therefore, invariably associated. Chronic inflammatory enlargement of the prostate may occur at any age after puberty; but the chronic enlargement of the gland in advanced life is quite distinct from any inflammatory state—it is an hypertrophied condition.

Structural Conditions.—The dissections by Sir H. Thompson and by Dr. Messer have thrown much light on the structural alterations which constitute chronic enlargement of the prostate. The tissues of which the prostate gland consists—in its normal or anatomical structure—are: first, unstriped muscular fibre, with connective tissue, forming at least three-fourths of the prostatic body; secondly, interspersed among this structure are numerous branching glandular tubes and crypts, with their accompanying ducts. Enlargement, or hypertrophy, may be determined by an abnormal production of the first-named elements alone; or with some of the glandular tissue interspersed, and which may be imperfectly or fully developed. The *parts* of the prostate thus affected may be the two lateral lobes (Fig. 902), which are sometimes increased to four or six times their natural weight and bulk; or an outgrowth may take place from the central part of the organ, in a backward direction towards the cavity of the bladder, as a

FIG. 902.*

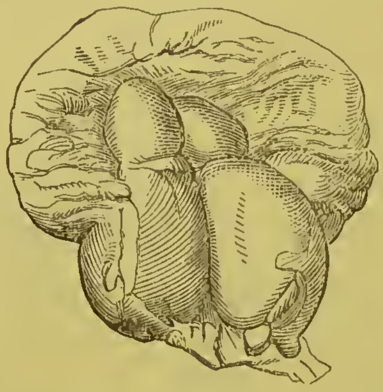
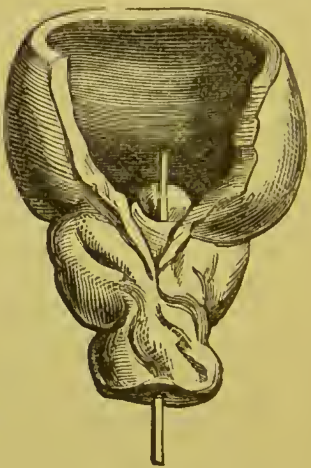


FIG. 903.†



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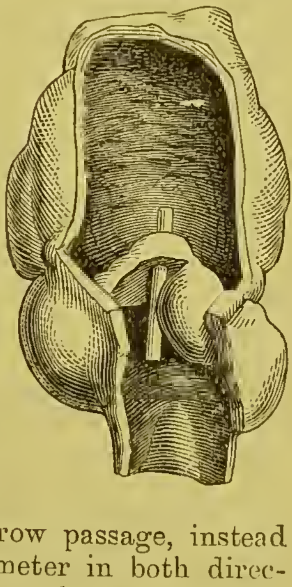
* St. Bartholomew's Hosp. Mus. Enlarged prostate; longitudinal section. (Mr. Pye.)

† Roy. Coll. Surg. Mus., 2491. Enlargement of the middle lobe of prostate, in the form of a round, smooth projection into the neck of the bladder, just behind the urethral orifice. Signs of the disease had existed for two years. (Sir A. Cooper.)

more or less rounded or pyriform tumour of prostatic tissue—the enlarged "middle or third lobe" (Fig. 903); and this form is one most commonly met with. Generally, the whole organ more or less partakes in the enlargement. (See Fig. 902.) *Isolated* tumours of prostatic tissue —*myomatous* tumours—are also very commonly produced, and found imbedded within the proper structure of the gland, or projecting as outgrowths. Consisting principally of the unstriped muscular tissue, with some portion of imperfect glandular prostatic structure, they form small, rounded bodies, varying in size from a pea to a filbert, and are sometimes completely isolated by a limiting fibrous cyst. These small imbedded tumours seem to have a relation to the containing organ, similar to fibrous tumours in the uterus. As a polypoid outgrowth, it may obstruct the prostatic portion of the urethra.

The *physical* characters of the enlarged prostate are not so definite as its structural condition. In consistence it is usually firmer and harder than natural, as if the organ were enclosed within a tight or stretched envelope; sometimes it feels looser and softer than natural. The formation of numerous fibrous tumours within the prostatic substance will more especially present the former character. In external colour there is no change from the healthy state, unlike malignant enlargement. The weight and size of a simply enlarged prostate are sometimes very remarkable. Taking the average weight of a healthy prostate to be four drachms and three-quarters, the average size is—from base to apex, one inch and a quarter to one inch and a half; transversely, one inch and three-quarters, exceeding the antero-posterior diameter by a fourth or fifth; and the greatest thickness five-eighths to seven-eighths of an inch (H. Thompson). Weight is a fair index to size. The enlarged prostate reaches commonly to eight or twelve drachms, or more than double the natural weight. A prostate weighing an ounce will have attained to the size of one inch in thickness from before backwards, and two inches in a transverse direction. Three inches transversely is not uncommon, and even four inches or rather more has been attained. The weight has been known to reach to twelve ounces.

Fig. 904.*



Structural *alterations* in the *Prostatic Urethra*, and *Neck* of the *Bladder*.—The consequence of prostatic enlargement is obstruction to the passage of urine; and this produces certain structural changes in the vesico-urethral portion of the canal. The *prostatic urethra* undergoes enlargement in its antero-posterior diameter, with diminution of its transverse or lateral diameter; the canal becoming a narrow passage, instead of being, when distended, of nearly equal diameter in both directions. In some cases, the prostatic urethra is enlarged laterally, forming an oval cavity (Fig. 904); and which may be increased by elongation of the canal. In point of length this portion of the urethra is always increased; measuring perhaps four inches from the orifice of the bladder to the membranous portion, instead of its normal length, one inch and a half. Its direction deviates from the natural passage. With enlargement of the middle lobe, the urethra rises abruptly as an angular curvature, instead of having nearly a straight line; thus presenting a complete step or "bar at the neck of the bladder" (Fig. 905), over which an instrument must be made to pass before it will enter the cavity. An outgrowth from the middle lobe occasionally forms as a valve, overlapping the vesical orifice (Fig. 906); and which, being forced forwards in the act of micturition, more completely obstructs the passage of urine. With enlargement of either lateral lobe, in addition to that of the middle portion, the lateral direction of the prostatic urethra is also changed; curving to the left when the right lobe is enlarged, and *vice versâ.* (Figs. 907, 908.) The *vesico-urethral orifice* or opening of the bladder undergoes alterations of shape; becoming crescentic (Fig. 909), with the convexity turned upwards, when the middle lobe is enlarged; or turned to the left or right, according as the enlargement of the lobe on the

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* Roy. Coll. Surg. Mus., 2513. The prostatic urethra is enlarged in its lateral diameter, as well as being elongated; forming an ovoid cavity one inch wide, when laid open, and two inches long. (Hunterian.)

FIG. 905.*

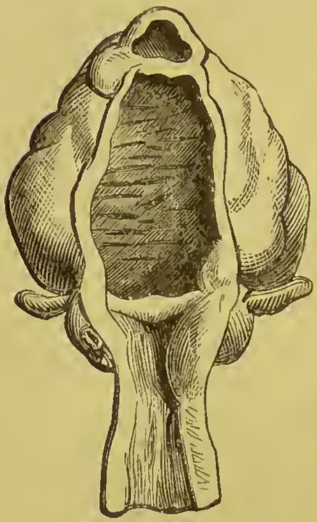


FIG. 906.†

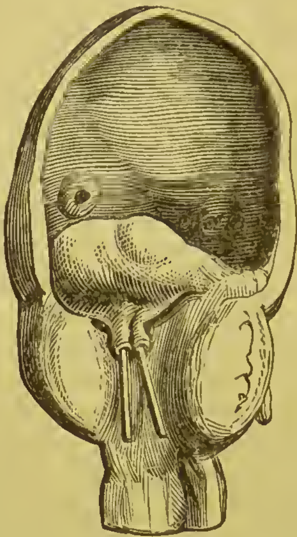
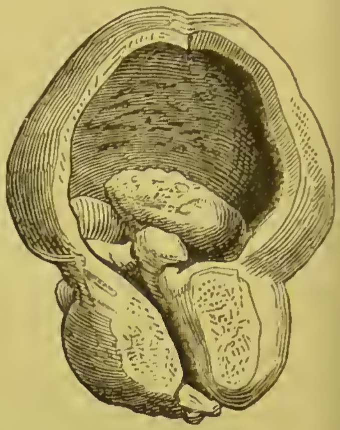


FIG. 907.‡



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* Roy. Coll. Surg. Mus., 2489. Enlargement of middle lobe of prostate, with two folds of thickened mucous membrane connecting it with the lateral lobes; forming a transverse bar at, or around, the posterior half of the urethral orifice. The patient was eighty years old, and had suffered many years with difficulty and frequent desire to pass water. Two attacks of retention of urine. Catheterism three or more times a day for the last three years of life, when death occurred from some intestinal disease. (Sir E. Home.)

† Ibid., 2497. Enlargement of middle lobe of prostate, in the form of an ovoid and somewhat flattened projection, about two inches and a half wide, and an inch and a half deep, nearly filling the neck of the bladder, and forming a high barrier behind and above the urethral orifice. The prostatic urethra is very deep and wide, and bifurcates posteriorly into two channels, one on either side of the enlarged middle lobe. The patient, eighty-one years old, had long experienced inconvenience, and increased frequency in voiding urine, without any surgical interference; at last retention of urine ensued, and the bladder was punctured above the pubes. (W. Lawrence.)

‡ Ibid., 2479. Enlargement of the *right* lateral lobe of the prostate, as a convex projection into the urethra; with nipple-form projection of the middle lobe, directed from the opposite side. Deepening of the prostatic urethra, and *curvature; its concavity* being turned towards the convex lateral lobe. (Sir W. Blizard.)

opposite side predominates; or, perhaps, by an enlargement of either *half* of the middle lobe.

Thus, then, the urethral canal, as a *whole*, is always *elongated* and *more curved;* while the prostatic portion and vesical orifice may sometimes together have also a *tortuous* course. These alterations, however, are necessarily alike dependent on the prostatic portion of the urethra; or, as regards the vesical orifice, on the prostate just within the bladder.

Fig. 908.*

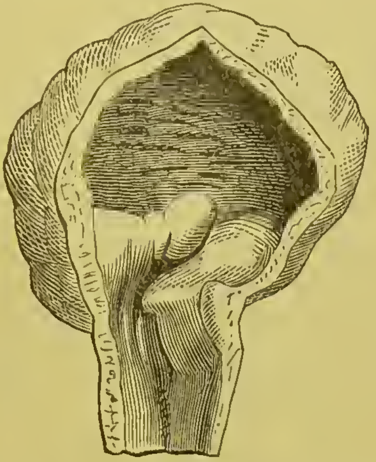
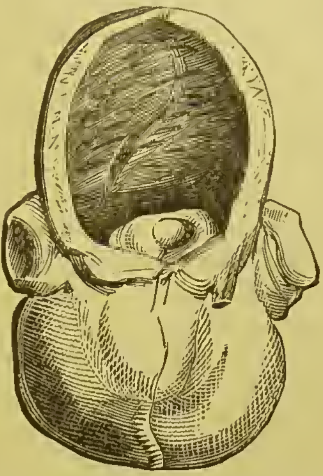


Fig. 909.†



The *causes* of chronic prostatic enlargement, or hypertrophy, are obscure. Various causes have been assigned, all of which are disproved by the searching examination to which Sir H. Thompson has submitted this question. All circumstances which tend to induce active determination of blood to the part, may aid in the development of hypertrophy. Hence, emotional excitement of a sexual kind, actual excesses, overstimulating food, sedentary habits, horse-exercise, and such like, may be enumerated as accessory causes of this affection. But the *initial* cause or origin seems to be unknown.

Symptoms.—Commencing insidiously, chronic enlargement of the prostate makes some perhaps considerable progress before any marked symptom supervenes. Then the symptoms manifested are:—increased frequency of micturition, with more or less urgency of desire; a bearing-down sense of weight about the neck of the bladder and rectum, with perhaps pain in the glans penis and testicles; a less forcible propulsion of urine, with delay rather than difficulty in its passage, but each act of micturition is felt to be incomplete and is concluded by an involuntary leaky dribbling; there may be slight hæmorrhage occasionally, and some muco-purulent discharge from the urethra. In addition to these four groups of symptoms, which severally may arise from other causes than enlargement of the prostate, there is the physical sign of an enlarged and more or less hardened state of this body, as discovered by passing the forefinger into the rectum, and feeling in the situation of the prostate at the neck of the bladder.

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* Roy. Coll. Surg. Mus., 2501. Enlargement of the *left* lateral lobe of the prostate, as a convex or angular projection into the urethra; with nipple-form projection of the middle lobe, directed from the opposite side. Deepening of the prostatic urethra, and *curvature;* its *concavity* being turned towards the convex lateral lobe. (Liston.) In this and the previous case, the curvature of the prostatic urethra is increased by the enlargement of the middle lobe having a direction from the *opposite* side.

† Ibid., 2481. Enlargement of the *right* lateral lobe of the prostate; showing *crescentic* urethral orifice, with its horns turned towards the right side. (Sir A. Cooper.)

Taking these symptoms in order, each may be observed more particularly. Increased frequency of micturition occurs mostly after the bladder has become distended during sleep, on rising in the morning, when the desire for relief returns in a few minutes. Uneasiness about the neck of the bladder may induce such expulsive efforts as to strain away some of the contents of the bowel during the act of micturition, at length leading to prolapsus and hæmorrhoids. Flattened motions and frequent erections of the penis are also not unfrequently concomitant symptoms. Increased frequency of micturition alone might seem to denote that the bladder cannot contain urine, owing simply to irritability of the organ; but the diminished force with which the stream is propelled, with the delay before it is established, and the sense of incomplete relief after apparently completing the act, are very significant of the state of the bladder. It cannot evacuate the urine, and remains partially, at least, distended.

Pathology supplies the true explanation of all these symptoms. The enlarged prostate projects upwards into the bladder, and urine accumulates in the receptacle thus formed behind the prostate. The bladder is never emptied below the level of the prostatic projection. Consequently, frequent, straining efforts are made; but the stream issues with less propulsive force, slowly and ineffectually; the surplus urine only or overflow passing off, the residual urine, often in large quantity, still remains below the prostate in the bladder. Even this occasional discharge can occur only when the bladder is sufficiently distended to obey its own contraction, and the straining compression of the abdominal muscles, to overcome the resistance offered by the enlarged prostate. An involuntary dribbling of urine takes place occasionally, from over-distension,—the incontinence of adults. Attacks of complete retention may supervene from any cause of temporary prostatic congestion; as by exposure to cold or damp, sexual excitement, or some error in diet; and such an attack is sometimes the first occasion of discovering the existence of prostatic enlargement. Complete retention and a distended state of the bladder is indicated by dulness on percussion above the pubes, extending possibly as high as the umbilicus. The slight hæmorrhage, and perhaps muco-purulent urethral discharge, not unfrequently happen under similar circumstances of prostatic congestion. Profuse hæmorrhage has been known to occur from transfixing a projecting portion of the prostate, in incautiously or forcibly passing a catheter.

The enlarged prostate, as *felt* on introducing the finger into the rectum, varies in size and consistence. Usually it is that of a large chestnut, or a small compressed orange, and of largest extent transversely,—stretching perhaps across the upper surface of the bowel from side to side at the neck of the bladder; or either lateral lobe may be enlarged singly, the right or the left. The consistence is usually firm and resisting, sometimes soft or unequally hard at different parts of the surface. It may be impossible to ascertain the extent of the enlargement backwards, which is often beyond reach of the finger. So also when the middle is principally, or alone, enlarged; this condition may escape detection by rectal exploration only. Thus, in anomalous cases, there may be a *nodular* enlargement, as of the right lobe and middle lobe (Fig. 910); or a circumferential ridge may be formed, as of the left lobe and middle lobe, around the vesical orifice. By tilting upwards and forwards the base of the bladder, some of the residual urine can be expelled; or by passing a catheter through the urethra, several ounces of urine—ten, twenty, thirty, forty, or more—may be drawn off, although the act of micturition had just previously been performed. The patient, who had imagined his inability to retain, is now convinced of his inability to expel his urine,—that his bladder retains too much.

FIG. 910.*

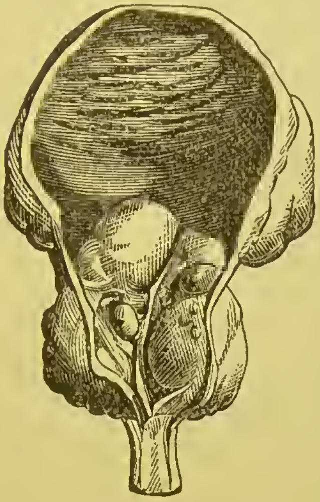
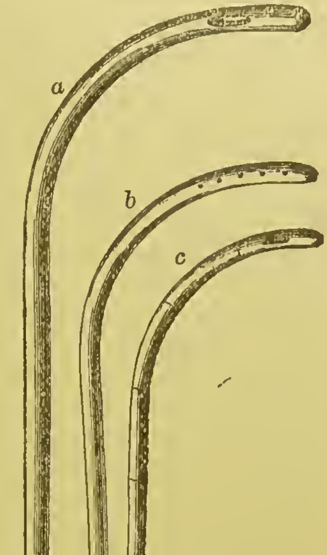


FIG. 911.†



Urethral exploration with a catheter will afford information which rectal exploration cannot convey, respecting the state of the middle lobe, and as to the elongation and curve of the urethra in its prostatic portion; thus completing the examination. For this purpose it is better to use, first, a full-sized catheter of the ordinary length and curve, as the standard of comparison; so that any alterations from the healthy condition may be at once made apparent. If, with no perceptible enlargement by rectal exploration, the urine flows when the instrument has traversed not more than the ordinary distance—about six to eight inches—while the handle has not been more than usually depressed, there will assuredly be no prostatic enlargement. But if the catheter has passed easily nine or ten inches and still no urine flows, while, following its course, the handle has become more than usually depressed, there will assuredly be enlargement of the prostate. Then the *prostatic catheter* should be used; a longer instrument by from two to four inches, and having a much larger curve. (Fig. 911.) The forms of curve preferred by Sir William Fergusson and by Sir H. Thompson, respectively, are shown to the right. The increased length and the altered direction of the prostatic canal can be estimated by means of this instrument; the one fact, by observing the length of shaft introduced; the other, by its position when the point enters the bladder. Any deflection of the instrument, to the right or to the left, when allowed to take its own inclination, will further indicate a greater degree of enlargement on the side *towards* which the handle inclines.

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* Roy. Coll. Surg. Mus., 2484. Irregular enlargement of the prostate; consisting of a nodular right lobe, and the middle lobe having two smaller knobs. Between these masses there is left only a narrow and crooked passage to the urethra. The prostatic portion of the urethra is very deep and narrow; the caput gallinaginis is large, and diverging fasciculi pass from it to the principal prostatic enlargements. The patient was eighty-three years old, and had suffered for more than thirty years from the usual symptoms of enlarged prostate, coupled with occasional incontinence of urine, and a sense of fulness in the rectum, which he could scarcely succeed in emptying completely. Retention of urine occurred about two months before death, but was easily relieved by the catheter. (Sir E. Home.)

† *a*, Prostatic catheter; *b*, Sir W. Fergusson's curve; *c*, Sir H. Thompson's curve.

Examination of the prostate, thus far, may be conducted advantageously, by using the finger in the rectum and the catheter in the bladder at the same time; the concerted movements of the two instruments indicating, moreover, the thickness of the prostate, as well as the length and course of the prostatic urethra.

Exploration of the urethro-vesical orifice and of the vesical portion of the prostate, with the fossa or receptacle behind it, can be severally effected by means of a *sound* having a very short curve or only a beak. On passing this instrument into the bladder, the beak is then turned down, and the post-prostatic receptacle sounded as to its depth, and searched for stone,—a not uncommon concomitant of enlarged prostate; in withdrawing the beak forwards, the posterior limit of the prostatic enlargement is ascertained,—a point not often ascertainable by rectal exploration; then the state of the middle lobe is determined, more clearly than by the upward curve in entering the bladder; finally, the condition of the vesical orifice, by turning the beak round to the right and to the left.

Diagnosis.—Enlargement of the prostate must be distinguished from: (1) stricture of the urethra; (2) stone in the bladder; (3) tumour of the bladder; (4) simple atony of the bladder; (5) paralysis.

In *Stricture*, the diminished force of the stream of urine is the same, or even less; but the volume is also diminished, even to that of the smallest stream short of retention; and, moreover, it becomes variously broken, twisted, or dribbling. Catheterism affords, however, the chief points of distinction; obstruction is encountered always before the instrument reaches the prostatic urethra, and generally before six inches of the instrument have disappeared. In enlarged prostate, seven, eight, or nine inches of the instrument will have disappeared without encountering obstruction; and not necessarily then, if the instrument be of sufficient length to enter the bladder. But the handle must be depressed between the patient's legs to a much greater degree than in passing stricture. The difference of age in the two cases will corroborate the diagnosis; stricture almost invariably appearing before middle life; prostatic enlargement not until after that period.

Stone in the bladder may be distinguished from enlargement of the prostate by certain features pertaining to each of the symptoms. Pain in the glans penis and vesical irritability are most marked *after* micturition, when the bladder is empty and the stone settles down on the more sensitive base of the bladder behind the prostate; and these symptoms are also then aggravated by exercise, or any movement whereby the stone rolls about on that part. The stream of urine often stops suddenly, by the stone falling over the vesical orifice; but this symptom is liable to happen also when an outgrowth from the middle lobe of the prostate exists in the form of a valve, which from time to time overlaps the neck of the bladder,—a rare form of prostatic enlargement. Vesical hæmorrhage is more common, as a symptom of calculus; the blood passed, florid and unmixed, is more abundant in quantity, and it is especially liable to occur *after* exercise by attrition of the stone on the mucous membrane of the bladder. Sounding affords conclusive evidence of stone, when the foreign body can be distinctly struck.

The *coexistence* of stone with an enlarged prostate—a not unfrequent combination—renders the diagnosis far more ambiguous. If the calculus lies in the receptacle behind the enlarged prostate, the pain in the penis and vesical irritability will be less marked or *absent;* this fact, originally noticed, I believe, by Sir B. Brodie, is probably owing to the removal of the foreign body from the sensitive neck of the bladder. Any indication by the sudden cessation of the stream of urine being equivocal evidence, it is then that occasional hæmorrhage, and especially careful sounding, as already described, afford the most reliable ground for diagnosis as to the existence of stone. But even the evidence derived from sounding may be masked by enlargement of the prostate. I remember to have heard from the late Mr. Thomas Morton (Surgeon to University College Hospital) of a case in his practice, where an instrument had been passed constantly by many eminent Surgeons during a period of fifteen years, without discovering the presence of a stone, which was found after death. Rectal exploration will more completely discover the prostatic enlargement.

From *non-prostatic tumour*, chronic enlargement of the prostate may be known principally by careful urethral exploration with the beaked sound; and by examination of any urethral discharge with the microscope, which reveals perhaps the presence of characteristic structural elements.

From simple *atony* of the bladder, the diagnosis of enlarged prostate turns upon the twofold fact; that when a catheter is introduced into the bladder, no urine, or scarcely any, flows in the recumbent position, nor is it much propelled by any efforts of the patient. Atony may, however, have supervened from over-distension, as a consequence of prostatic enlargement. In *paralysis* of the bladder, when a catheter is introduced, urine flows, and in a stream as full and forcible as after removal of the obstruction of an enlarged prostate; but there is inability on the part of the patient to propel the urine by any voluntary action of the abdominal muscles, this inability being of course proportionate to the completeness of the paralysis. The lower extremities also are almost always involved, and this paralytic condition results from injury or disease of the nervous centres,—brain or spinal cord.

Consequences, and Terminations.—Chronic cystitis, or a state of the bladder bordering on it, commonly ensues from the habitual retention of urine, and distension of the bladder. Hence the characters of the *urine*, in chronic enlargement of the prostate, are such as depend on decomposition of some of its constituents, from retention, mixed with the products of chronic inflammation of the vesical mucous membrane. The interior of the bladder changes in colour to a greyish slate hue, as seen after death; and viscid mucus or purulent matter, streaked with whitish phosphatic deposit, and occasionally tinged with blood, is voided in the urine; which is alkaline, and of a pungent ammoniacal or fœtid odour. Perhaps a deposit of urates and uric acid takes place, in connection with a gouty diathesis. The quantity of urine passed varies much from day to day; the measure being generally much above, although sometimes below, the average healthy standard. The patient's general health declines during the course of his habitual retention, and inflammatory affection of the bladder. As the result of broken rest, from ineffectually relieving the bladder, and constitutional disturbance owing to the state of the organ, he becomes sallow and dejected, he loses flesh and strength, and "ages" fast. Occasional attacks of complete retention throw him further back. A *gradual decline* of health takes place; or *rapid depression*, from ulceration or sloughing of the bladder, with repeated hæmorrhage, or from profuse purulent discharge. *Uræmia*, from suppression of urine, sometimes closes the scene.

Post-mortem Examination.—Certain *pathological conditions* of the bladder, ureters, and kidneys result from the mechanical and backward effect of long-continued retention of urine. They are discovered *after* death. The *bladder* is thickened, principally in its muscular coat, and its hypertrophied muscular bands project inwards in the form of prominent fasciculi; between which the mucous membrane protrudes externally, and has become sacculated under the constant pressure of the retained urine. At the base of the bladder, a pouch or receptacle has formed behind the enlarged prostate, capable of holding perhaps several ounces of the ammoniacal, fœtid urine; and in which mucus and phosphatic concretion-matter are also apt to accumulate. The backward pressure of urine distends, and eventually dilates the *ureters;* and the secreting substance of the *kidneys*, in their pyramidal and cortical portions, are atrophied; resulting even in sacculated remnant kidneys. Hence, suppression of urine, and uræmic blood-poisoning.

Treatment.—Palliative measures alone have any effect in chronic enlargement of the prostate; and they relate to the relief of retention by catheterism or other operative interference, the prevention or relief of chronic cystitis, and the maintenance of the general health.

Retention of Urine.—Having regard to the constant retention of a certain quantity of residual urine in the bladder, the organ should be emptied mechanically, at least once a day, or twice or three times; according to the amount of obstruction, and the consequent accumulation of residual urine. The *prostatic* catheter is larger sized, longer, and more curved than an ordinary catheter; and thus being adapted to the corresponding alterations in the urethra, the urine can be more conveniently drawn off by this instrument. Two points should be observed in passing the instrument into the bladder: not to mistake the dilatation of the prostatic urethra for the bladder, an ounce of urine perhaps thence escaping, as if the instrument had entered its cavity; and in the next place, to depress the handle of the instrument sufficiently, so as to curve upwards into the bladder and avoid hitching against any enlargement of the middle lobe. Care should be taken to empty the receptacle behind the prostate, by turning and depressing the point of the instrument. The patient should be taught to pass it in his own person, that he may relieve himself as occasion requires. A gum-elastic catheter, of large size, will then be more convenient and safer than the silver instrument; the patient introducing it bit by bit. When the point of the instrument has reached the prostatic urethra, the stylet is to be withdrawn, that the curve of the catheter may slide upwards into the bladder. Mercier's *sonde coudée*, a beaked elastic catheter, may prove advantageous when an obstruction arises from enlargement of the middle lobe, more especially; or the *sonde bicoudée*, having a second beak, is thus adapted to mount up more readily into the bladder. (Fig. 912.) As a rule, it will be unnecessary and undesirable to allow the catheter to remain in the bladder; but if it be requisite to procure ease and sleep, this continued use of the instrument affords great comfort. It may be left in the bladder during the night, for example. The gum-elastic or a vulcanized india-rubber catheter is then preferable, as being less liable to irritate the mucous membrane. By thus habitually relieving habitual retention, the patient's existence is rendered more tolerable or even enjoyable, and life may be considerably prolonged.

FIG. 912.

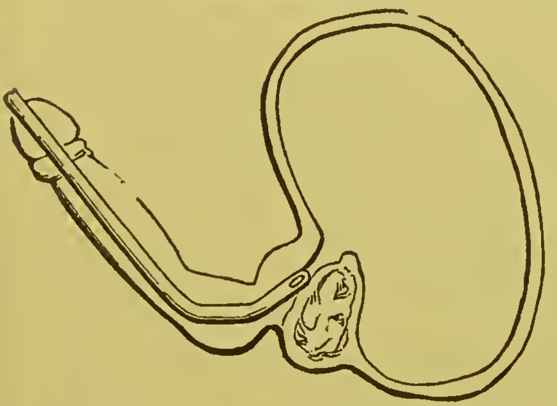
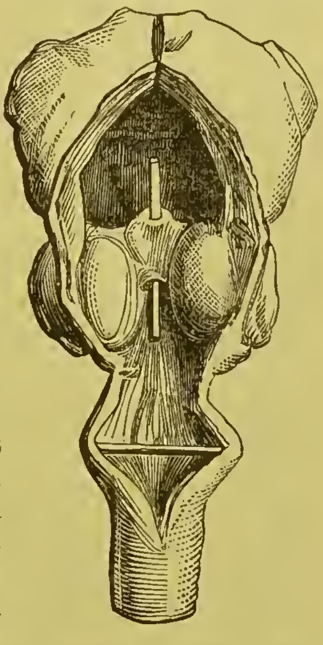


FIG. 913.*



When no instrument can be got into the bladder, other methods of gaining an entry may be resorted to. They are—forcible catheterism or tunnelling the prostate; puncture of the bladder through the rectum; or puncture above the pubes.

Of these three methods, *forcible catheterism* is recommended by

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* Roy. Coll. Surg. Mus., 2509. Effects of forcible catheterism; showing tunnelling of the enlarged *middle* lobe of a prostate. The prostatic and membranous portions of the urethra were acutely inflamed, and near the glans penis abscess had probably occurred. The patient, an old man, had often previously been relieved of retention by means of a catheter; but a Surgeon, having found some difficulty in entering the bladder, perforated the prostate with the instrument; and death ensued in two or three weeks. (J. G. Crosse.)

Brodie, Liston, Spence, and other Surgeons of large experience, as a safer procedure than puncture through the rectum, or above the pubes. The instrument, having been thrust through the obstructing portion of the prostate (Fig. 913), is left in the bladder for about forty-eight hours, to establish a false passage for its re-introduction.

Puncture through the rectum, and above the pubes, will severally be more appropriately considered and described in connection with stricture of the urethra.

The tendency to *chronic cystitis*, as dependent on prostatic enlargement, may be averted; partly by preventing retention, partly by careful regulation of the diet, and the avoidance of exposure to cold or damp, or other causes of any disordered state of the urine, or of determination of blood to the bladder. Remedial treatment is considered in connection with this vesical affection.

The maintenance of the general health must be conducted on ordinary principles, chiefly of a hygienic character.

Atrophy of the Prostate.—This prostatic condition is sometimes found in old age, and occasionally in early adult life. The prostate gland is but slightly developed in men whose sexual character is not strongly marked, and in some malformations. No special symptoms or treatment are known.

Cancer of the Prostate.—Cancer is met with less commonly as a secondary deposit, than as a primary disease of the prostate. The form of cancer is almost always encephaloid, and sometimes it is associated with melanotic deposit; scirrhus seems to be of doubtful occurrence.

Age has apparently a certain relation to malignant prostatic disease; it has been observed only in childhood and advancing age. No authenticated cases, observes Sir H. Thompson, are on record between the ages of eight and forty-one.

The *symptoms* are those of prostatic enlargement; but distinguished by the severity of the pain, and its shooting into the rectum, up to the sacrum, and down the thighs; the oft-recurring and more abundant hæmorrhage; and, perhaps, constitutional cachexia. The tumour examined through the rectum, as compared with chronic prostatic enlargement, is of larger size, harder, and perhaps of irregular shape; subsequently becoming softer and fungating. The adjacent lymphatic glands are affected, both lumbar and inguinal; confirming the diagnosis. The urine has been said to exhibit, under the microscope, characteristic cancer cells; but the resemblance of the epithelial cells renders this evidence doubtful. Marked rapidity of the symptoms, however, distinguishes the malignant disease; its duration from first to last extending not longer than from one and a half to five years in adults, and from three to nine months only in children.

The *treatment* is palliative. Catheterism should be avoided if possible, and then performed with the gentlest touch, not to irritate or injure the part. Anodynes in the form of opium or conium may be administered both by mouth and rectum. Hæmorrhage must be treated as explained in connection with hæmaturia. The general health and strength will require all the support which can be given by tonics and a nutritious diet.

Cysts.—The substance of the prostate is often beset with numerous small cavities, of an irregular shape, and communicating with the ducts of the glandular structure. They are apparently dilated prostatic follicles. Some such cysts contain several minute concretions or prostatic calculi of larger size, and each occupying a separate recess. Old age is most liable to this cystic condition of the prostate.

No special symptoms are presented by these small cystiform cavities, and the diagnosis is unimportant, as it would not afford any indication for special treatment.

A cystic condition of the prostate is sometimes met with, resulting from long-continued suppuration with absorption of the glandular substance; and thus forming one large cavity containing pus. The capsule of the prostate has become the pus-secreting sac of an *abscess.*

A *hydatid cyst* has occasionally formed between the bladder—near its neck—and the rectum. This condition is attended with retention of urine and distension of the bladder; simulating the symptoms of prostatic enlargement. The formation of any such cyst within the substance of the prostate seems doubtful.

Tubercle.—The prostate is very rarely the seat of tubercular deposit, and then always as a secondary affection; some other part of the genito-urinary tract being the primary seat of deposit. The kidney ranks first, and next the testicle. Phthisis pulmonalis is generally associated with the tubercular affection of any genito-urinary organ. Prostatic tuberculosis occurs most commonly between the ages of twenty-five and fifty-five. Extreme ages, in youth or an advanced period of life, would appear to be eleven and seventy-six years, as gathered from eighteen cases collected by Sir H. Thompson. Frequent and painful micturition, with some obstruction to the passage of urine, and occasionally slight hæmorrhage, constitute the symptoms. There is also some amount of prostatic enlargement, ascertainable by rectal examination. Subsequently, with suppuration and discharge, the prostate becomes smaller than natural, and the urine purulent. But the absence of any special symptoms, and the coexistence of at least a phthisical tendency, will so far indicate the nature of this disease.

Treatment must be conducted on general principles.

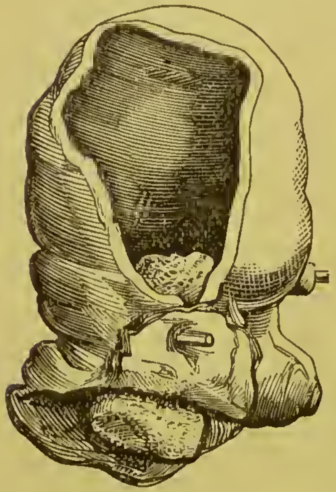
Prostatic Calculus.—The prostate gland, like other glands, is liable to an inspissation of its secretion, forming nuclei around which inorganic deposit and concretion takes place, within the ducts of the follicular structure. This mode of origin and situation is characteristic of true prostatic calculus, and distinguish it from urinary calculus which may have lodged in the prostate. Prostatic calculus is composed principally of phosphate of lime, about eighty-four per cent., with a trace of carbonate of lime; organic matter, fifteen per cent., constituting the remainder.

The physical characters of these calculi are peculiar:—their colour is generally a brown chestnut, sometimes black, red, or white; occasionally transparent or like pearl-barley; of softish or hard consistence; their form is commonly very irregular, faceted, triangular, or square; and their size varies from that of granular sand to a poppy-seed or cherry-stone. In point of number, one, two, three, or more, even to a hundred, may exist, like a bag of marbles. By constant attrition, the facets become smooth and polished. Continued deposition of phosphatic matter at length produces a larger calculus, encroaching on the rectum, or coming forward out of the mouths of the distended prostatic pouches into the prostatic urethra; thence it extends forwards, or backwards into the bladder, forming a prostato-vesical calculus. Sometimes one or more prostatic calculi become detached, free and movable in an open duct. These enlarged calculi have a very irregular or branched appearance.

A remarkable prostatic calculus was presented by Dr. H. Barker to the Museum of the Royal College of Surgeons. It has a pyriform shape; measures in length nearly five inches, in circumference at its thickest part four inches and five-eighths; and weighs three ounces and a half. The stone consists of twenty-nine pieces, the facets of which are regularly fitted together; indicating that its formation took place in the crypts of the prostate, separately, and that the pieces coalesced by subsequent absorption of the glandular substance, thus resulting in this multiple calculus.

The *symptoms* to which prostatic calculi give rise, depend principally on their size. When small, there may be no symptoms, or such slight inconvenience as not to attract attention. When of larger size, they are attended with pain and weight in the perineum, and uneasiness at the neck of the bladder; there is frequent micturition, sometimes retention, and difficulty in the emission of semen, although attacks of priapism may have misled the sufferer to more frequent sexual intercourse. All these symptoms point to an enlarged and irritated prostate; and, by urethral or rectal exploration, one or more stones can be touched with an instrument, or felt through the prostate with the finger. (Fig. 914.) On passing a sound through the urethra, a distinct click or grating is heard and felt, just before the beak of the instrument enters the bladder; a deeply imbedded calculus may be felt, on passing the finger up the rectum, or by simultaneous examination with the finger and sound. A large number of small stones communicate to the finger a crackling or grating sensation, like that of small marbles in a bag.

Fig. 914.*



As the result of prolonged irritation, suppuration may ensue, forming prostatic abscesses.

Having found a calculus in the prostate, what *treatment* should be adopted? When there are no urgent symptoms, the case may be wisely left alone, so far as regards any attempts to remove the stone by operative interference. Symptoms of irritation can perhaps be subdued by opiate suppositories, and careful regulation of the bowels to prevent any rectal constipation; while retention of urine is relieved by using the catheter as occasion requires. If the calculi are small and movable, they may admit of extraction through the urethra, by means of a long urethral forceps. But this mode of operation is not easily accomplished. When the stones are large, and not more than two or three in number, median lithotomy should be performed, and extraction effected with scoop or forceps. A larger-sized calculus had better be removed by the lateral operation.

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* Roy. Coll. Surg. Mus., 2039. (Prostatic?) Calculus, of large size, remaining in the prostatic urethra and neck of the bladder, after lithotomy. The patient, aged fifty, lived for two years after the operation, with all the symptoms of stone, and the wound remaining open. (Liston.)

Sometimes the Surgeon has to deal with a urinary calculus or fragment, lodged in the prostatic urethra. Here the urethral forceps can more often be employed with advantage; or failing thus to remove the stone, it may be pushed back into the bladder, and submitted to lithotrity or lithotomy.

Lastly, the occasional coexistence of prostatic and vesical calculus presents a difficulty in the way of the lateral operation. Yet, under these circumstances, this mode of removing both calculi may alone be practicable.

CHAPTER LXIV.

DISEASES OF THE URETHRA.

THESE diseases have been incidentally alluded to, as associated with vesical and prostatic affections, and may be thus enumerated:—(1) Inflammation of the Urethra, or Urethritis, and its more specific form, Gonorrhœa; (2) Stricture or contraction of the canal, in some part or parts of its extent,—as a structural or organic and permanent condition, or as a spasmodic or an inflammatory state; (3) Tumours occasionally; (4) Urethral Calculus. The results of Urethral obstruction comprise—Retention of Urine; Extravasation; Rupture of the Bladder; and Urinary Fistulæ,—penile, scrotal, perineal, urethro-vaginal, and vesico-vaginal fistulæ.

URETHRITIS.—*Simple* inflammation of the urethral mucous membrane may arise from various causes, at any age, and in either sex. Any one who may be thus affected experiences heat, pricking, and tension in the urethra for a day or two, with some scalding sensation in passing water; symptoms which are followed by a muco-purulent discharge. Sometimes the only symptom is this whitish discharge from the urethra, unaccompanied with any inflammatory character.

The *diagnosis* of this urethral affection, in either form, is very important, from its resemblance to Gonorrhœa. In the *active* condition of simple urethritis, the distinction from Gonorrhœa is extremely difficult; in the *passive* condition, it resembles gleet, but differs in the thicker and more opaque character of the urethral discharge. The causes of simple inflammation of the urethra differ also from that of gonorrhœa, which arises from a specific contagion; though here, it must be confessed, the line of distinction is even less definite.

Certain constitutional causes, gout, rheumatism, scrofula, and the influence of particular medicines, as guaiacum or cayenne pepper, frequently induce urethritis. These causes seem to affect the urethra by morbid states of the urine, as when it is loaded with lithic or with oxalic acid; thus producing *direct* irritation in the passage of such urine. They give rise to the active form of urethritis, and the discharge usually disappears immediately upon the development of the constitutional disease. Scrofulous urethritis is, however, apparently a local manifestation of the general disease, just as there may be a discharge from the nasal mucous membrane. *Distant* irritation, as gastric derangement, worms in the intestines, or teething, may also excite a urethral discharge; but this is of a passive character. Local causes of various kinds are not unfrequently the occasions of urethral irritation; as the passage of instruments, sexual intercourse or excitement, the introduction of vaginal discharges,—such as the menstrual fluid, or leucorrhœal matter. Here, again, the discharge is usually passive.

All these causes should be taken into consideration before pronouncing a professional judgment as to the particular cause in any case of urethritis. Thus, in a young child, the existence of vaginal and urethral discharge is not absolute evidence that a rape has been committed; and in persons who are subjects of stricture and irritable urethra, a discharge apparently gonorrhœal sometimes exists, or appears after sexual intercourse or excitement, or debauch, or other cause of urethral irritation.

Simple urethritis generally subsides in a week or ten days, unlike gonorrhœa, which continues some weeks or even months. But the discharge often becomes chronic in gouty persons, or when associated with stricture.

Treatment consists in removing any cause of urethral irritation, and allaying the inflammatory symptoms. Thus, in a gouty or rheumatic case, both these indications may be answered by the administration of alkaline, saline aperients, combined perhaps with colchicum; aided by a moderate and non-stimulating diet. When the discharge has become passive, weak astringent injections, as of the diacetate of lead, alum, or sulphate of zinc, will gradually arrest the urethral secretion and complete the cure. I never use the two latter forms of astringents, nor find it necessary to have recourse to copaiba or cubebs.

As associated with stricture, urethritis may occasion a temporary retention of urine, partly spasmodic. Then, in addition to what is termed antiphlogistic treatment, the relaxing influence of opium or opiate suppositories, and a warm hip-bath, will usually overcome the obstruction. The use of a catheter should be postponed until relief cannot be otherwise obtained.

Gonorrhœa or *Blennorrhagia.*—This form of urethritis is attended with muco-purulent discharge, of a *specific* character; and is generally produced by contagion or contact with a *similar* discharge, usually during sexual intercourse. It may affect, and infect, either the male or female.

In the *male*, the urethra is the seat of gonorrhœa, and particularly the anterior portion of the mucous membrane,—as far as the fossa navicularis within the glans penis; but the urethral inflammation sometimes extends backwards along the whole length of the passage, and may even involve the mucous membrane of the bladder, in extreme cases. When gonorrhœal inflammation subsides into a chronic state, the bulbous portion of the urethra is more especially affected, the intermediate anterior portion up to the glans being comparatively free. Other portions of the genital mucous membrane are often *secondarily* involved, as that of the prepuce and glans.

The *symptoms* of gonorrhœa differ in the course of the disease, and which may thus be divided into four tolerably definite stages. Commencing generally from the second to the fifth day after contagion, a short period of urethral irritation is followed by acute inflammation, which subsides into a declining or chronic stage; terminating perhaps in gleet, a chronic state of peculiar discharge which does not always supervene.

Urethral irritation is attended with very slight symptoms: an itching or tickling sensation in the meatus, its lips have a florid red and puffed appearance, and are glued together by a scanty, viscid, clear and colourless, or slightly opalescent secretion. In passing water, some smarting is experienced, but no scalding—no ardor urinæ. This stage lasts from a few hours to two or three days.

Acute inflammation gives rise to the discharge of a purulent secretion, having a thick, creamy consistence, and opaque and greenish-yellow colour; it can be pressed out of the urethra in sulphur-looking drops, and is usually so abundant as to stiffen the shirt in patches; an acute scalding pain is felt in passing urine, which is voided with some difficulty in a diminished or forked stream, or in spasmodic jerks, and with increased frequency; although the patient refrains from micturition as long as he can contain, regarding this procedure as quite a little operation. The whole glans penis is turgid and of a bright cherry-red colour; the urethral canal is swollen and cord-like to the touch; the prepuce may become œdematous, and at length the whole penis looks and feels turgescent. Should the inflammation pass back to the bulbous urethra, a sensation of weight in the perineum will be experienced, and, reaching the prostatic urethra, a bearing-down weight about the anus is superadded. The heavy and enlarged penis seldom remains pendent and quiescent for many hours by day or night; under any rubbing irritation of the dress, or warmth in bed, erections often occur with troublesome inconvenience; or *chordee* not unfrequently arises, in the form of a painful arching or twisting of the penis downwards during erection, a penalty inflicted in oft-repeated attacks. This bent position of the organ in erection seems to be the result of lymph-effusion around the urethral canal, producing an inextensible state of the corpus spongiosum at the part affected. Whenever, therefore, an erection would take place, as the cavernous body of the penis becomes distended, the unyielding spongy urethra acts like the string of a bow, and bends the penis downwards. Another explanation is, that chordee arises from spasm of the muscular fibres around the urethra.

The characteristic discharge and scalding micturition constitute what is vulgarly called the "clap" in England, and "chaudpisse" in France. Some feverishness may accompany this acute inflammatory stage of gonorrhœa; but often there is little constitutional disturbance. The average duration of this stage is from one to three weeks; its continuance varying according to the number of previous attacks and the habits of the patient.

The *chronic* stage is denoted by the altered character of the urethral discharge; the pus subsides into muco-purulent matter, which is thinner and less copious; and the scalding reverts to smarting or only a soreness in micturition. In about another three weeks, the gonorrhœa may pass off,—under treatment; but it rarely terminates spontaneously in less than three months. During a severe and protracted gonorrhœal discharge, the general health undergoes a marked depression; so that the individual may be almost known by his haggard, pallid, and listless appearance.

Gleet.—Blenorrhœa or gleet must be regarded as the sequel, rather than the concluding stage, of gonorrhœa; for it does not invariably result. The urethral discharge has now become a thin, nearly clear and colourless, or almost watery fluid, oozing in small quantity, or so scanty that it has to be pressed out of the meatus for examination; no scalding or other inflammatory symptoms remain; yet this discharge is persistent—lasting for many months or even years. Thus, we speak of an old-standing, gleety urethral discharge. It may be maintained by certain constitutional conditions: a scrofulous, rheumatic, or gouty diathesis; a lymphatic, weakly temperament; or simply by a state of debility. The discharge retains its contagious nature for a long or indefinite period; and it is ever liable to be developed into a more virulent puriform secretion by slight exciting causes. Sexual intercourse, therefore, is always unsafe, so long as *any* discharge exists, of whatever kind, or in the smallest oozing of secretion.

I have already noticed the *diagnosis* of gonorrhœa from simple urethritis. No positive distinction can be trusted from the appearance of a urethral discharge, its contagious character, or from its having been produced by contagion. As Ricord truly observes, "Gonorrhœa often arises from intercourse with women who themselves have not the disease;" and, yet more explicitly, Diday affirms "that from the very fact of a woman having a discharge, no matter what its origin, she is liable to give a discharge to a man." Bumstead bears similar testimony as to the possibly non-specific origin of gonorrhœa in a man from an uncontaminated woman. It is, therefore, of the utmost social importance not to overlook the difficulty or impossibility of a diagnosis, as affecting the moral character of any woman, who as a wife or mother would suffer the most wrongful and cruel imputation by a rash or erroneous professional judgment; blighting also the domestic happiness of those with whom she is connected. Nor need I dwell on the further responsibility of the practitioner respecting any such question, when made the subject of Medico-legal inquiry; as perhaps criminally affecting a chaste woman. In the male sex also, *any* persistent urethral discharge—whether from gonorrhœa, as gleet, or of non-specific nature—may equally prove contagious to a woman.

These considerations give a wider significance to the *causes* of gonorrhœa than was formerly understood. Gonorrhœal matter or virus, and occasionally any other discharge—as menstrual fluid or leucorrhœal matter, or even the ordinary uterine or vaginal secretions—may severally communicate, or give rise to, true gonorrhœa. The distinction between gonorrhœa and simple urethritis, in virtue of the *specific* nature of gonorrhœal pus, is now generally acknowledged to be no longer tenable. The contagious character of gonorrhœal pus is more virulent, and the symptoms induced are generally more severe; but, from a causative point of view, the only distinction is, that simple urethritis arises from other causes,—constitutional and local, as well as from any contagious discharge.

The following additional practical facts, although not perhaps exclusively characteristic of gonorrhœal contagion, appear to be well established:—(1.) The disease is not communicable by sexual intercourse *before* the discharge appears. (2.) After the discharge is established, if the urethra be previously washed out by means of a water-injection, the disease will probably not be communicated. (3.) The matter retains the power of infection for an indefinite period; in one case Titley found that a girl had communicated the disease immediately on leaving the Magdalen Hospital, after a seclusion of one year; and in another case, according to Hunter, after two years' seclusion. (4.) With gleet, two persons thus affected may have intercourse with impunity; but either of them will communicate gonorrhœa to a sound person. (5.) The violence of the symptoms depends very much on constitutional conditions, as the gouty diathesis, and habits of life, as intemperance; consequently, the same woman may give a very mild gonorrhœa to one man, and a most severe one to another. (6.) The first attack of the disease is generally the most severe; a kind of urethral tolerance being commonly induced by repeated attacks. (7.) The severity and the continuance of gonorrhœa are often inverse; it is most severe in young and plethoric persons, in the gouty or rheumatic diathesis, and in the first attack; but most obstinate in scrofulous and phlegmatic constitutions, in persons affected with chronic skin-diseases, and after repeated attacks. (8.) The disease seems to be much milder now than formerly.

The *generation* of gonorrhœa, apart from exposure to any discharge, is a question which may be so far entertained that it has not been entirely disproved; but many apparent cases of origin are rendered very doubtful by the persistently contagious character of the slightest gleety discharge. In relation to *syphilis*, the virus of gonorrhœa differs entirely in its nature from that of chancre or of chancroid; neither disease being capable of reproducing the other under any circumstances. The two diseases are distinct, not convertible.

An ordinary case of gonorrhœa passes through an unchequered course, until the discharge runs itself off. But several morbid conditions of the urethra or of adjoining parts may *complicate* the natural history of this disease. *Chordee*, a bent and painful erection of the penis, has been already noticed. Urethral *hæmorrhage* is apt to occur, from rupture of the engorged vessels during violent erections, and especially in chordee. This event is unimportant; the loss of blood usually being slight, it affords relief. Inflammation and suppuration of some of the *mucous follicles* of the urethra may occasion some temporary obstruction; until the abscess bursts into the urethra, or perhaps externally, as a less favourable issue. Irritation or inflammation of the *urinary organs* is a far more serious complication of gonorrhœa; sometimes affecting the posterior portion of the urethra,—giving rise to severe perineal pain, with spasmodic stricture, and more or less retention of urine; sometimes extending back to the bladder,—as denoted by the more urgent and painful micturition, with mucous deposit in the urine; or there may be the symptoms of renal irritation, amounting even to nephritis,—announced by pain in the loins, shivering, vomiting, and albuminous, bloody, or purulent urine. This state, with or without cystitis, is likely to be induced by early or strong urethral injections, intemperance, or the use of copaiba in large doses. Inflammation of the *inguinal lymphatic glands*, or *sympathetic bubo*, occurs during the second or inflammatory stage of gonorrhœa. But such buboes rarely proceed to suppuration, unless when subjected to irritation, or in persons of a scrofulous and debilitated constitution. *Balanitis*—an inflammatory affection of the mucous membrane of the prepuce and glans—is known by a thin, opalescent discharge from this part, often profuse and excoriative. Persons who have a long prepuce are most liable to it; but it is engendered by uncleanliness, hot weather, or disordered health. As the result of swelling of the prepuce and glans, *phimosis* or *paraphimosis* is not unfrequently met with in conjunction with gonorrhœa. Thus, the prepuce cannot be retracted, or not easily, behind the glans, so as to uncover it; or the prepuce cannot be drawn forwards from behind the glans, so as to cover that part of the penis. Various cutaneous eruptions on the prepuce are occasionally concomitants of gonorrhœa. *Herpes præputialis* appears in the form of small vesicles, containing a thin, opalescent fluid; and which are disposed in clusters of two, three, or four, upon the internal or external surface of the preputial fold. Roseola, pityriasis, and psoriasis sometimes make their appearance; usually, from six weeks to three months after the commencement of gonorrhœal discharge.

A patient having escaped any mishap in the course of gonorrhœa, is yet liable to the *consequences* of this urethritis. *Orchitis*, or inflammation of the testicle, is not uncommon; commencing as epididymitis, and resulting in a swollen state of the organ. Gonorrhœal *rheumatism*, or *synovitis*, sometimes arises from sudden arrest of the discharge, or after exposure to cold; the metastatic inflammation affecting one or more joints; usually the knee, and often both knees. In some cases the discharge continues. The synovitis is marked by an abundant serous effusion, and the disease terminates without disorganization, in a few weeks. It may, however, proceed to ulceration of the cartilages, and continue for months or a year or two. In one such case, under my care, the knee-joint became firmly anchylosed. Gonorrhœal *ophthalmia*, an acute purulent inflammation of the conjunctiva, may occur in consequence of the accidental application of the urethral discharge to the eye,—an inoculation of gonorrhœal matter to another mucous membrane. This mode of origin does not seem to be always indisputable; for both eyes are often affected, and usually at an interval of a few days, the eye attacked last generally suffering least. Gonorrhœal *sclerotitis*, an inflammatory affection of the sclerotic or fibrous coat of the eye, may be of a rheumatic character. Occasionally, gonorrhœa or gleet is followed by *prostatorrhœa*, a chronic inflammation of the prostate gland; characterized by the discharge of a few drops of clear, transparent, or slightly turbid viscid mucus, after micturition or any straining effort of defæcation. This fluid is not semen, as it contains no spermatozoa. There is also much irritability about the neck of the bladder, and sensitiveness of the prostatic urethra in passing an instrument; with loss of strength, and mental langour or hypochondriacal lowness of spirits.

The *treatment* of Gonorrhœa varies according to the stage of the disease.

During the incipient stage—*urethral irritation*—it may be possible to prevent the accession of the inflammatory stage, by means of "abortive" or "revulsive" treatment, which comprises astringent urethral injections, and the specific influence of copaiba or cubebs. But any such agents, if used for that purpose, are very hazardous, by perchance exciting intense inflammation. So far as opportunity may offer for this practice, I believe it is generally abandoned.

Inflammatory stage—acute and chronic.—From the commencement of a gonorrhœal purulent discharge, reducing measures, followed by suppressive injections, may be employed,—according to the degree of urethral inflammation. When *acute*,—with an abundant, thick, opaque yellow, or creamy discharge, and scalding in passing urine,—the appropriate treatment consists in gentle saline, alkaline, aperient medicine, an unstimulating diet, abstinence from wine, beer, or spirits, with rest and recumbency. As a topical application, immersion of the penis in very hot water, for a few minutes, is said to afford great relief. When the inflammation has passed into the *chronic* stage,—with a diminished, thinner, and clearer discharge, and the absence of scalding in micturition,—the previously reducing measures should be discontinued, and succeeded by acid tonics; or perhaps copaiba or cubebs, and astringent urethral injections, may be used. In *gleet*—the discharge having now become scanty, thin, clear, and colourless, as a watery oozing from the urethra, and lasting for a considerable period—the same suppressive measures will also be appropriate.

By the foregoing plan of treatment, I have almost invariably prescribed with success, in some thousands of cases. Commencing with an aperient and alkaline mixture—containing sulphate of magnesia, in about drachm doses, with a little senna, and the sesquicarbonates of soda and ammonia, in doses sufficient to nearly neutralize the urine—in three weeks or more the urethral inflammation will have safely subsided; the patient having abstained from any indulgence in wine or other alcoholic beverage, and stimulating food, especially peppers and condiments. The discharge has now undergone the characteristic change in quantity and appearance to that of the chronic stage; and the scalding pain on micturition has also ceased, leaving only a slight smarting or soreness in passing urine. *Then*, the discharge may be *safely* suppressed, gradually, by using an injection twice a day; consisting of about ʒij. of the liquor plumbi diacetatis to ℥ij. of distilled water. Other injections, if not preferable, may be preferred. Thus, the subnitrate of bismuth in mucilage, grs. x. to ℥j. of water, with a little morphia or belladonna; nitrate of silver, grs. i.—ij. to ℥j.; chloride of zinc, grs. i.—iv. to ℥iv.; sulphate of zinc, gr. i., gradually increased to grs. iv., to ℥j.; sulphate of zinc and acetate of lead ana grs. xxx. to ℥vj., an injection long in use at the old Lock Hospital; or acetate of zinc, grs. xii. to ℥iv. of water, is the favourite injection of Sigmund, Milton, and Bumstead. In obstinate *gleet*, the bichloride of mercury may prove successful; gr. $\frac{1}{4}$ to ℥j. of water. Before using any injection, the patient had better pass his urine, in order to clear the urethra of gonorrhœal matter, which would prevent contact with the mucous membrane; and also to avoid the necessity of emptying the bladder again for some time, care being taken to drain away any urine from the urethral canal. These two latter precautions have regard to any decomposition of the injected solution by the action of the urine. Owing to such change, a lead injection becomes opaque and curdled when discharged; and nitrate of silver acquires a milky-white opacity; both solutions having been made with distilled water. An injection is thrown up the urethra by means of a small glass syringe; and so that it shall be applied only to the affected portion of the urethral tract, the finger is placed under the canal, just in front of the scrotum. For deeper injection, as mostly in gleet, various forms of catheter-syringe have been devised, principally by Tiemann. Astringents in the form of powder can be injected to any particular part of the urethra, by means of Mallez's breech-loading metallic tube.

Bougies, besmeared with an ointment of nitrate of silver, or the balsam of copaiba, may be passed along the urethra; but this mode of making topical applications is not in general use. In old-standing *gleet*, the introduction of a bougie occasionally, even where no stricture exists, is highly beneficial. It should be of sufficient size to occupy the urethra without distending the passage; be left in for about ten minutes at a time, and be passed twice or thrice a week. Blistering the penis, in obstinate gleet, has found favour with some Surgeons; the unguentum lyttæ, spread on lint, is wrapped around the body of the organ, and applied for not longer than two hours. The effect is said to be singularly curative, when the gleety discharge is uncomplicated by stricture or orchitis.

The medicinal treatment of chronic suppurative discharge, and of watery gleet, is best fulfilled by an acid-tonic mixture of cinchona with sulphuric acid; but towards the close of the case, the sulphate of iron should be given, to repair the anæmic condition. Such treatment as may be suitable in the various other constitutional conditions, must not be overlooked; as in the scrofulous, rheumatic, or gouty diathesis, on which a gleety discharge may depend. Certain medicinal agents have apparently a *specific* influence in arresting the discharge, and especially the two renowned specifics—copaiba and cubebs. Some Surgeons urge the employment of these medicines in the acute stage of gonorrhœa. Neither should be administered when it manifestly disagrees with the patient; nor continued on trial beyond a week or ten days, when no beneficial effect has been obtained by that time. Both these specifics are apt to disturb the digestive organs, and produce symptoms of renal irritation; and copaiba sometimes induces a cutaneous rash, in the form of small red patches, more or less circular, somewhat like nettle-rash. But the various *preparations* of these medicines are not equally to be commended. Copaiba may be given in capsule, pill, or draught. The capsule—an envelope or coating of gelatine, containing a small bolus of copaiba—is an elegant and convenient preparation; the envelope disguising the nauseous taste and peculiar odour of the balsam. Six or eight capsules may be taken daily. The French *dragées* are also much used, particularly in America. In the form of a pill, consolidated with magnesia, copaiba sometimes acts more effectually, a drachm being taken thrice daily; or combined with dilute sulphuric acid, fifteen minims, and mucilage in infusion of roses, as a mixture, this medicinal agent is better tolerated by the stomach. Cubebs may agree when copaiba will not. The dose of the powder is a drachm, three times a day. Both specifics are sometimes advantageously taken together, in such proportions as to form the consistence of an electuary; of which a drachm will be the dose, thrice daily. I never find it necessary to prescribe either copaiba or cubebs, and have for some years discarded them. In concluding the treatment of gonorrhœa, hygienic resources may prove singularly beneficial. The tepid or cold sponge-bath, with friction afterwards, sea-bathing, an open-air life, avoiding horse-exercise, will often succeed in finishing off an otherwise lingering case. Smoking should be prohibited. As any persistent urethral discharge might be contagious, sexual intercourse must be strictly forbidden.

Chordee is best prevented or overcome by a nightly pill of opium and camphor,—say, one to two grains, as an anodyne antispasmodic; or conium and camphor, in pill, I have often ordered with marked relief. Camphor alone may be taken, as Mr. Milton directs; one drachm of the tincture in water, before going to bed, and repeated every time the patient wakes with chordee. Or Ricord's suppository—of opium, the watery extract, one grain, with camphor ten grains—may be introduced into the rectum an hour before bedtime. The patient must deny himself supper or any excitement before going to bed, and then bathe the parts with cold water, or preferably with hot water until a sensation of faintness is produced; he should lie on a hard mattress, and be lightly covered with bed-clothes.

Gonorrhœal *epididymitis* and *orchitis* may be treated by rest in the recumbent position, warm fomentations, and leeches if necessary; but sedative measures, especially hyoscyamus in full doses, with camphor mixture, will often prove sufficient to subdue the pain and swelling of the testicle; while, if the urethral discharge has been suddenly suppressed, I am in the habit of soliciting its return by enveloping the penis in a poultice.

Gonorrhœa in the Female is a much less common affection than in the male sex. But the inflammation and discharge is rarely restricted to the urethra; the vagina is the chief seat of gonorrhœa. The symptoms are heat and itching in the vagina, with scalding in the urethra when the urine is passed; on examination, the vaginal passage is found to be red and swollen; these early symptoms being soon followed by a copious, greenish-yellow, muco-purulent discharge, proceeding more especially from the upper wall of the vagina. The labia may become involved, appearing red and puffed, while the secretion from the sebaceous follicles gives an offensive character to the discharge. Sometimes the inflammation extends backwards to the os uteri, which presents small patches of superficial ulceration. But all the symptoms are usually milder than in the male; and although perhaps of longer duration, the discharge does not generally pass into gleet. Simple vaginitis must not be mistaken for gonorrhœa; and yet their *diagnosis* cannot be determined by any one symptom, or by the combination of symptoms, nor by the appearance of the discharge or its inspection with the microscope. This absence of any distinctive evidence is a very important consideration in relation to medico-legal inquiry respecting supposed gonorrhœa in young females and children, who are very liable to simple inflammation of the vagina from various causes, both constitutional and local. The diagnosis is scarcely less doubtful with regard to vaginal uterine discharges at any period of life.

Fewer untoward events are likely to *complicate* the course of the disease in women than in men. Not unfrequently one of the swollen labia suppurates, the abscess pointing on the inner side. There may be some inguinal sympathetic bubo, but perhaps only in cases where the urethra is affected; and sometimes the vaginal inflammation creeps up into the cavity of the uterus, and may even pass up the fallopian tubes to the ovaries; the ovaritis thus induced corresponding to epididymitis in the male. Gonorrhœal rheumatism is a rare occurrence, and gonorrhœal ophthalmia is seldom met with.

Treatment may be comprised in a few words. No special remedial measures are requisite, but the topical applications must be made directly to the part affected. Thus, injections must be thrown up the vagina so as to reach the seat of inflammation, and lotions should be applied by means of a fold of lint placed well in between the labia.

STRICTURE OF THE URETHRA.—Among diseases of the Urethra, Stricture justly ranks high in its importance; whether on account of its frequency, the distress it occasions, its serious and fatal consequences when neglected, or the unquestionable means for cure or relief.

The term Stricture of the Urethra signifies an unnatural narrowing or contraction of this passage, at one or more points in its extent. This may depend on either of three distinct conditions:—(1) Lymph-deposit in the mucous and submucous tissues, as the result of chronic inflammation,—and thence known as Organic or Permanent Stricture; (2) Spasmodic contraction of the muscular fibres encircling the mucous membrane,—Spasmodic Stricture; (3) Inflammatory congestion of the mucous membrane,—Inflammatory Stricture. The two latter conditions of stricture—spasm and inflammation—often coexist; and either may be engrafted for a time on organic stricture.

ORGANIC OR PERMANENT STRICTURE.—Four forms of organic stricture of the urethra may be recognized, according to Sir H. Thompson's accurate observations:—*linear* stricture, in which the urethral canal is obstructed by a thin, membranous septum, having a central aperture; or a crescentic septum, which obstructs a segment only of the calibre of the canal; thus forming the "bridle stricture;"—*annular* stricture, a thicker and broader, contracted portion of the urethral canal, as if a piece of cord had been tied around it at one point, leaving the remainder free (Fig. 915);—*indurated annular* stricture, a more confirmed contraction, in which the induration involves the tissues of the urethra to the depth of half a line or a line, limited in length from before backwards to less than half an inch of the canal, and forms an hour-glass contraction, usually thicker on the floor than at the upper aspect of the urethra;—*tortuous* or irregular stricture, owing apparently to adhesion of the rugæ of the urethra to a short extent, or to a cicatricial patch of induration, or a longitudinal contraction and induration to an extent of one or more inches. (Fig. 916.) In this condition of stricture, the

FIG. 915.*

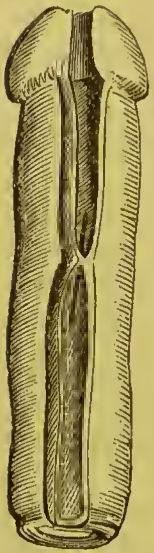
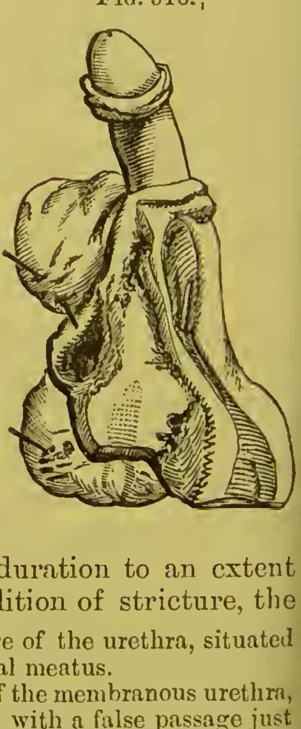


FIG. 916.†



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* St. Thomas's Hosp. Mus., DD. 44. Annular stricture of the urethra, situated in the spongy portion, nearly three inches from the external meatus.

† Roy. Coll. Surg. Mus., 2552. Long, narrow stricture of the membranous urethra, and in the first inch of the bulbous and spongy portions; with a false passage just in front, and a large irregular abscess in the perineum, having numerous fistulous openings,—perineal, scrotal, and in the right buttock; but the abscess does not communicate with the urethra. (Hunterian.)

induration may involve the entire substance of the corpus spongiosum, presenting the most obstinate and undilatable form of stricture.

Situation of Stricture.—The urethral canal is liable to stricture in three situations:—(1.) At the junction of the spongy and membranous portions, or within an inch before, and three-quarters of an inch behind, that point. Of these situations, the most common seat of stricture is the bulbous part of the spongy portion—anterior to the triangular ligament; rarely, behind this membrane, in the membranous portion, and most rarely as far back as the posterior part of the membranous portion. No instance has been found of stricture of the prostatic portion of the urethra. The above strictures correspond to the subpubic curvature.

(2.) In the centre of the spongy portion, or that portion of the urethra which extends from the anterior limit of the preceding to within two inches and a half of the external meatus, a length of about three inches.

(3.) At the external orifice, and within a distance of two inches and a half of it.

These definitions as to the situations of urethral stricture result from a laborious examination, by Sir H. Thompson, of 270 preparations in our principal public Museums, and comprising 320 distinct strictures. In region 1 were found 215, or 67 per cent. of the entire number; in region 2, 51, or 16 per cent.; in region 3, 54, or 17 per cent. Mr. H. Smith made a similar investigation of this question, on a smaller scale; the preparations numbering 98, as preserved in the different London Museums. Of these, 77 were strictures situated anterior to the triangular ligament; and 21 only, in the membranous portion of the urethra.

Several strictures may coexist in the same urethra. John Hunter records an instance of six strictures in one urethra; Lallemand and other French writers describe seven or eight; Sir H. Thompson has never been able to find any such examples, and he limits the highest number of coexisting strictures to three, or at the most four. In the above number of 270 preparations, eight were cases of stricture in all three regions; ten in regions 1 and 2 only; ten in regions 1 and 3 only; thirteen in regions 2 and 3 only.

The urethral obstruction occasioned by stricture gives rise to symptoms which are individually, or collectively, significant of this condition. Increased frequency of micturition arises, owing to the inability to completely empty the bladder; the stream of urine becomes smaller than is natural to the individual, and altered in form, being either flattened, twisted or corkscrewed, forked, or turned aside; and discharged with a less forcible propulsion, so that the current is not ejected as far from the person as formerly, and at length issues as a mere dribbling or in drops.

As the obstruction *increases*, the muscular coat of the bladder gradually strengthens, and hypertrophies, in order to compensate for the difficulty in ejecting the urine through the strictured urethra; and as this thickening of the bladder proceeds, its capacity is proportionably diminished, less urine can be retained, and micturition must be even more frequent. This state, annoying and inconvenient during the day, is distressing at night, when exhaustion would invite to rest; the sufferer being repeatedly aroused from his temporary doze, and the night passed in restless efforts to obtain relief. After each act of micturition is apparently completed, another significant symptom is experienced; a certain portion of urine still escapes as a dribbling leakage, owing to the propulsive force of the remaining urine being insufficient to overcome the resistance of the stricture, which was dilated by the stream passing when the bladder was full. After the act of micturition is actually quite finished, a certain portion of urine can sometimes be squeezed out by pressure behind the seat of stricture, from the dilatation of the urethra in that situation. Pain is usually felt in the canal behind the stricture, during the effort to pass urine; and by constant straining, some feculent matter or flatus escapes at such times, and a tendency to prolapsus of the bowel is established. In a paroxysm of straining effort, rupture of the urethra may occur, behind the stricture; and then extravasation of urine takes place into the cellular texture of the perineum, scrotum, and supra-pubic region. In the act of coitus, much pain is experienced about the ejaculatory ducts, and, as the semen escapes with difficulty through the urethra but passes back into the bladder, there may be no seminal emission; and the unhappy patient believes himself actually, as he may be virtually, impotent. The urine undergoes those changes which result from chronic cystitis, consequent on retention. It becomes ammoniacal, cloudy, and deposits more or less mucus and pus, with phosphates. Hæmaturia is an occasional concomitant of stricture; the blood coming from the mucous membrane of the bladder, or perhaps from the urethra after catheterism or an erection of the penis affecting the seat of stricture. A gleety discharge not unfrequently attends old stricture of the urethra.

The general health fails, the patient losing flesh and strength: he has an anxious and careworn appearance; suffers from pains in the loins, lower part of the belly, the perineum, and testicles; and is subject to severe attacks of rigors. Any irritation of the urethra, as by passing an instrument or the application of an irritant substance, will often provoke such an attack, especially in those who have lived in hot climates; or it not uncommonly excites general feverishness—hence named "urethral fever," and which has sometimes an intermittent character.

Certain *varieties* of organic stricture may be recognized by some peculiarity of their respective symptoms:—

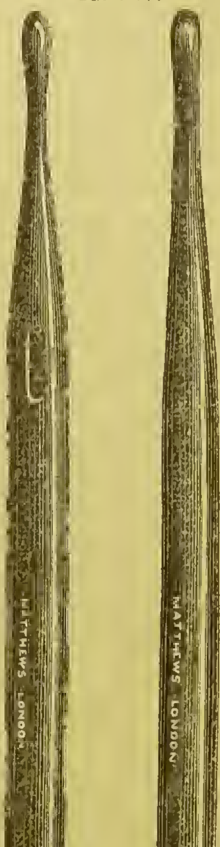
Simple stricture; chiefly denoted by diminution in the size of the stream of urine, with the other ordinary symptoms of stricture.

Sensitive or *irritable* stricture.—Proneness to disturbance of the nervous system, as manifested by chilliness or rigors on very slight urethral irritation; and pain, sometimes persistent, from the gentlest passage of an instrument. A disposition to hæmorrhage is evinced in a few cases.

Contractile or *recurring* stricture—distinguished by a constant tendency to further diminution of the urethral canal, in the absence of treatment; and contraction recurs rapidly after dilatation has been effected.

Examination of the Urethra.—Catheterism, or what I would term, bougieism—the use of a bougie—supplies the most direct and conclusive evidence as to the existence of stricture; evidence analogous to that of sounding for stone in the bladder. The presence of stricture, its situation, its calibre, the extent of the canal involved, and the amount of induration, may be thus severally determined; and whether also there be one or more strictures. Instruments of various composition and form are used for this purpose: *catheters*, which may be inflexible, as the ordinary silver instrument, or flexible, as gum-catheters; and *bougies*, which are solid instruments of flexible metal, or flexible and more or less elastic, as the ordinary gum-elastic bougie, wax or catgut bougies. Catheters may be curved or straight. The former shape is generally applicable; and the curve most commonly suitable is that which corresponds most nearly with the bend of the urethra at its inner third—an arch rather less than one-fourth of the circumference of a circle three inches and a quarter in diameter. Straight instruments are preferable for strictures in the ante-scrotal portion of the urethra. The *probe-pointed steel stricture-staff*, such as that used in perineal section, affords the surest indication as to the situation of stricture in the course of the urethra; the shoulder of the instrument being arrested by the constriction, its anterior limit is thus declared. At the same time, on passing the finger into the rectum, the narrow portion of the staff can be felt to have passed through the stricture at the membranous urethra. The *catheter*, or *bougie olivaire* (Fig. 917) possesses two advantages—a bulbous or spear-headed end, and flexibility; it can therefore be insinuated, or passed with a screw-like action, into a tight stricture, and readily takes the course of an irregular urethra, without causing a false passage, pain, hæmorrhage, spasm, or rigors. This instrument, invented by Lioutt and originally advocated by Mr. Teevan, in this country, is now much used. The *bougie à boule*, having a conical-shaped extremity, is another flexible and elastic instrument of much use in the diagnosis of stricture.

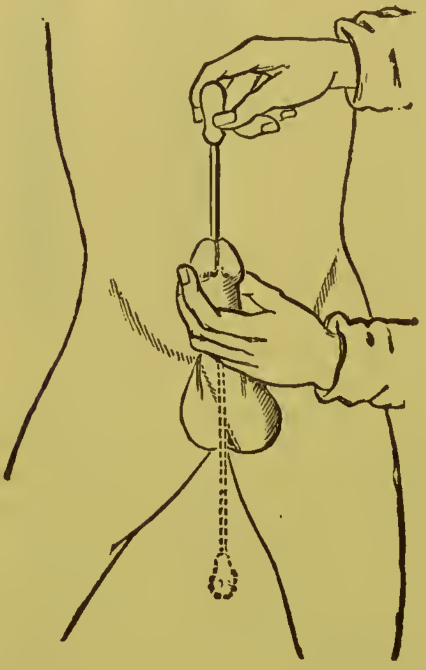
Fig. 917.



The *introduction of a catheter* may be performed in either of two ways: in the recumbent position, and with the curve of the instrument directed upwards; or in a standing position, and with the curve of the instrument looking downwards. Of these two methods, the former is usually more easy and convenient both to the patient and Surgeon. The patient lying down on his back, with the shoulders a little raised, the legs thrown easily apart and slightly drawn up, an instrument of appropriate size—No. 7 or 8—is selected, and warmed by a little friction up the sleeve for a few seconds, and then oiled or smeared with lard. In introducing it, the handle should be held lightly between the thumb and the fore and middle fingers of the right hand, the concavity of the curve looking upwards towards the left groin of the patient, and the direction of the instrument being nearly horizontal. (See Fig. 918.) Raising the end of the penis with the thumb and finger of the left hand, so as to draw it up to its full length, the double curve of the urethral passage, somewhat resembling an italic *S*, is thus changed into one curve, commencing from just in front of the scrotum;

and this single curve corresponds to the curve of the instrument, as it passes along the urethra from that point downwards and upwards into the bladder. The point of the instrument—held as directed—is now inserted into the urethral meatus and carried slowly onwards along the floor of the canal, to avoid the lacunæ on its roof, until four or five inches have disappeared; the handle is brought, at the same time, to the middle line, but still parallel and near the patient's abdomen; then it should be gently raised, and, as the point of the instrument passes under the subpubic curve, the handle is carried forwards and lightly depressed until it sinks below the horizontal line, when the opposite end will turn upwards into the bladder. (Fig. 918.) After the point of the instrument has passed below the scrotum, its further progress in the right direction may be facilitated or maintained by guiding it between the fore and middle fingers of the left hand, under the pubes; and sometimes the introduction of the forefinger into the rectum will aid in determining the middle line onwards to the bladder. That the bladder is entered is announced by some escape of urine through the catheter, on withdrawing the stylet, and by freedom of the point on attempting to rotate the instrument from side to side. But no urine will escape when there is only a small quantity in the lower fundus of the bladder, and the patient recumbent; and I have noticed that, in the sitting or standing position, there may be a small or dribbling stream, even when the bladder is nearly full, owing apparently to temporary atony or paralysis of the organ. After a few minutes, the urine may be drawn off freely, or discharged in a full stream. In passing a catheter, any slight resistance may be obviated by manipulating the instrument, in respect to its direction, or withdrawing it for an inch or so and then repassing it. But the presence of *stricture* is determined by an arrest of the instrument point blank, and at the same part of the urethra, on each re-introduction. If, however, the point of the instrument is only stuck in a lacuna or some fold of the mucous membrane, the point will feel loose, and should be disengaged; whereas, when it has entered fairly into the stricture, the point is felt to be grasped tight, and then it should be gently urged onwards. Remembering the situations of stricture, this obstruction will be found usually behind the scrotum, in the subpubic curvature; less frequently in the ante-scrotal portion of the urethra. No force should ever be used; nothing more than the pressure of a light hand, exercised slowly, continuously or intermittently, and with patience. Any departure from this injunction may lead to perforation of the urethra and the formation of a "false passage;" and this misadventure is the more likely to happen when the

FIG. 918.*



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* The instrument here represented is a sound, instead of a catheter.

handle of the instrument is being depressed, whereby the shaft acts as a powerful lever on the point in the urethral passage.

The other method of introducing a catheter—when the patient stands upright—is performed in the *opposite* manner to that in the recumbent position. It is the "tour de maître" of French authors. The patient standing with his back to a wall, so that the nates shall not recede during the procedure, and with his legs a little apart, the instrument is introduced with the curve looking downwards, and the handle in a perpendicular line beneath, the penis being drawn straight forward. Having passed the instrument in this direction as far as the subpubic arch, it is swept round to the right and raised upon the abdomen, thus describing a semicircle, of which the catheter-point is the centre; then the handle is gradually depressed, so as to carry the point of the instrument through the subpubic curve into the bladder.

The *existence* of stricture having been ascertained by the obstruction offered, at some point, to the introduction of a catheter along the urethra, its *situation* may be estimated by feeling the end of the instrument behind the scrotum, or in front, as the case may be, and noted more accurately by the length of the instrument passed from the external meatus. The *degree* of contraction or the calibre of the canal at that point can be estimated by the size or number of the instrument used; the *extent* of the canal involved, by the length of the instrument "held" or "grasped" from the point of entering the narrowed portion of the urethra; while, at the same time, the amount of *induration* may be judged of by an experienced tact. A second or third stricture is discovered in like manner, by continuing the urethral examination.

To complete the examination of any one or more strictures, several instruments, of different sizes, will perhaps be necessary. In the English scale of 12, the five series from 7 downwards will generally be found most serviceable for this purpose. The French scale possesses three advantages over the English scale: it commences with a smaller size—one millimètre, or one-third of an inch, instead of five millimètres, and ascends by a series of smaller intervals between each number; the intervals are more regular; and the number of the catheter represents the calibre or size of the instrument—No. 1 being one millimètre, No. 2 is two millimètres, and thence, by similar gradations, up to thirty millimètres. Nos. 3 to 21 about equal Nos. 1 to 12, English scale. No. 7 or 8 (English) size should always be tried first; a smaller-sized instrument is liable to hitch in one of the urethral lacunæ, or against the verumontanum, or in the sinus pocularis, as if it were fixed in the stricture; or it might pass through the stricture imperceptibly. Either occurrence would mislead the Surgeon. The smaller the instrument, the greater caution and delicacy must be observed in using it; lest, incautiously, the urethra be perforated. A soft *wax* bougie has been recommended with the view of taking an impression or mould of the size and extent of the stricture. Any such supposed advantage is more then neutralized by the difficulty of finding the stricture, as compared with the facility in using an inflexible instrument.

The introduction of *bougies*, which are now much employed, require no special directions for their use.

Causes.—Two classes of causes may be recognized as resulting in the formation of an organic stricture.

(1.) Inflammation of the urethra, with *plastic deposit* in the mucous and submucous tissues; thereby glueing together the organic muscular layer which immediately underlies the mucous membrane, and in virtue of which the canal naturally undergoes temporary alterations of calibre, by relaxation or contraction. This kind of cause comprises gonorrhœa; the inflammation extending along the canal, and being of a severe or long-continued character. The symptoms of stricture supervene very slowly and insidiously; a period of many years perhaps elapsing before the existence of this organic constriction is declared. Simple urethritis may have the same result, but only under the operation of some persistent constitutional condition. Injections for the cure of gonorrhœa tend to the formation of stricture, when used in the inflammatory stage, or of too great strength, or long continued. Thus, an injection of nitrate of silver, one to two grains to the ounce of water, can do no harm; but in the proportion of ten grains to the ounce, it may certainly produce stricture. Abscess in a lacuna of the urethra, followed by contraction of the *cicatrix*, is an occasional cause; and cancerous or other ulcers may similarly result in the formation of stricture, usually near the external meatus. Amputation of the penis sometimes issues in like manner.

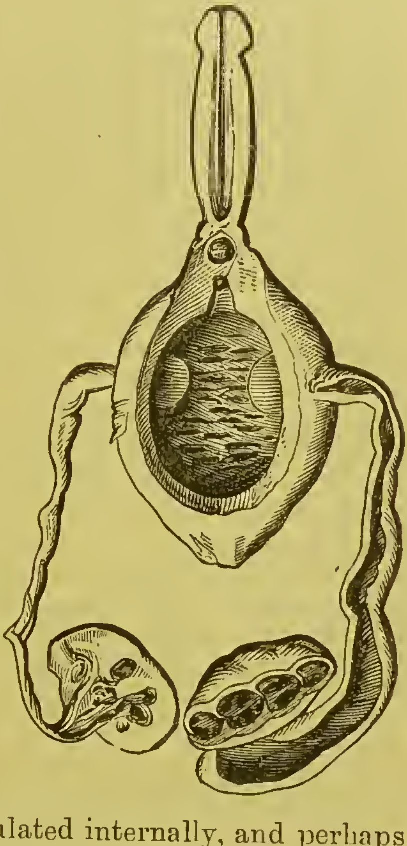
(2.) Injury to the urethra by external violence on the perineum, bruising, lacerating, or rupturing the urethra, is followed by a *cicatrix*, the contraction of which is very apt to result in stricture of the most severe and intractable character. This kind of cause comprises kicks on the perineum; falls on some hard projection, as across spars, scaffolding, ladders, chairs, saddles, gates, wheels, etc.; puncture of the perineum, by palisading, by an earthenware vessel breaking under the sitter, etc.; laceration, by pelvic fractures involving the urethra; and lastly, by the forcible introduction of urethral instruments.

Congenital stricture is occasionally met with, near the external meatus. In early life its existence is unattended by any inconvenience; but in adult life it gives rise to serious obstruction of the passage of urine, when the urethral tissue has become less extensible.

Consequences, and *Terminations*.—The course of stricture is very similar to that of chronic enlargement of the prostate. *Chronic* cystitis, or a state of the bladder bordering on it, commonly ensues from the habitual retention of urine and distension of the bladder. The characters of the *urine* are in accordance with that condition. The *general health gradually declines*, as the result of broken rest from ineffectually relieving the bladder, and of constitutional disturbance owing to the state of the organ, aggravated by occasional attacks of *spasmodic retention;* or the constitutional symptoms may be those of increasing *nervous prostration* with oft-repeated rigors, induced sometimes by each act of micturition, or simply by the use of an instrument; and *rapid depression* may supervene, either from ulceration or sloughing of the bladder, with recurring hæmorrhage, or from profuse purulent discharge. *Rupture of the urethra* is liable to occur, owing to dilatation and ulcerative opening of the canal immediately behind the stricture; followed by *extravasation of urine*, with its attendant symptoms. This may happen at a more or less remote period. I have known extravasation occur in traumatic stricture, twenty-six years after the injury,—a fall on the perineum across a beam; and also in stricture from gonorrhœa, five years previously. Rupture of the *bladder* is a very rare event. Both these consequences of Stricture are dependent on Retention of Urine, and they will be noticed under the head of Extravasation of Urine. *Suppression of urine*, with uræmia, sometimes arises from slight urethral irritation; as by the introduction of an instrument only one size or number larger than that to which the patient is accustomed, or in consequence of a slight urethral abrasion, or from the mere passage of an instrument. Severe rigors and suppression of urine are both far more apt to occur when disease of the kidneys exists, so that the one becomes a tolerably sure indication of the other; and the fatal issue is more rapid and inevitable.

Certain *pathological conditions* of the urethra, prostate, vesiculæ seminales, bladder, ureters, and kidneys, result from the mechanical effect of long-continued retention of urine. They are discovered, mostly *after* death. The *urethra* is contracted in calibre before, and dilated sometimes into a sacculus just behind, the seat of stricture. In the latter or dilated pouch, sabulous matter and even calcareous concretions occasionally collect. Rupture of the urethra may have taken place in this dilated portion; and in connection with an abscess, usually perineal. This abscess may have opened externally, as well as communicate with the urethra, —constituting a fistula in perineo, with perhaps several branch fistulous openings and surrounding consolidation. The ejaculatory ducts also, in the sinus pocularis, are enlarged. The *prostate* gland has been found converted into an abscess, multilocular, or as a single cavity, bounded by the fibrous capsule; and communicating by one or more ulcerated openings with the prostatic urethra. The *vesiculæ seminales* are then often distended with glairy and fœtid, purulent matter. The *bladder*, subjected to the constant backward pressure of urine, which distends its cavity, is fasciculated internally, and perhaps sacculated; the one alteration of this organ representing an hypertrophied state of its muscular bands; the other, intervening pouch-like protrusions of the mucous membrane. The general result is a diminution in the capacity of the bladder for the retention of urine (Fig. 919),

FIG. 919.*



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* Roy. Coll. Surg. Mus., 2540. Close annular stricture at the anterior part of the membranous urethra. Immediately in front is a small, round, and deep depression, produced probably by the points of instruments passed down to the stricture; just behind is a dilated sacculus, containing a small, imbedded calculus. The walls of the bladder are much thickened, from hypertrophy of its muscular coat, and thickening of the mucous membrane, which is partly covered with lymph, from acute cystitis; the ureters and pelves of the kidneys are much dilated,—the mid-portion of the left ureter being, however, almost closed; and the substance of both kidneys is atrophied and sacculated. The prostate gland is healthy. In this case, the patient was only thirty-six years old, of very intemperate habits, and had suffered from stricture for six or seven years. (T. G. Crosse.)

or its total capacity may be thus much increased. Rupture of this organ may have happened, though very rarely. Sometimes, it takes place in consequence of a small pin-hole aperture of ulceration in the mucous membrane of one of the sacculi. The *ureters* have undergone dilatation by the tendency to reflux of urine, and the pelvis of these tubes may thus be found much enlarged; while the *kidneys* are more or less degenerated and atrophied in their pyramidal and cortical portions, resulting perhaps in sacculated remnant kidneys, or in the formation of mere bags or cysts. Sometimes these organs are beset with multiple abscesses, as the result of pyelitis or nephritis from the backward irritation of prolonged retention. Hence the suppression of urinary secretion, with uræmic blood-poisoning.

Treatment.—The object of treatment is twofold: to restore the urethral canal to its natural calibre, and to maintain that state of patency. But for the accomplishment of this object, different modes of treatment are necessary according to the various states of stricture; its degree of contraction and induration or dilatability, its sensitiveness and proneness to disturbance of the nervous system, its contractility and disposition to return. All the modes of treatment may be reduced to four: (1) Gradual Mechanical Dilatation; (2) Immediate and Forcible Dilatation, or Rupture; (3) Caustics; (4) Division of the Stricture, either by internal urethrotomy, or by external urethrotomy,—usually perineal section.

GRADUAL MECHANICAL DILATATION,—inducing absorption of the plastic deposit around the seat of stricture. This method of treatment is most generally applicable; the other methods being resorted to when it proves ineffective, or when it is contra-indicated by one of the adverse states of stricture above mentioned.

The *instruments* used for gradual dilatation are catheters and bougies,—inflexible, or flexible and elastic; and always of gradually increasing size.

The selection of an appropriate instrument, in respect to its material, terminal shape, size, and curve, if an inflexible instrument, will depend on the degree of contraction and the situation of the stricture; both these points having been determined by urethral exploration with a catheter or bougie, as already explained in completing the diagnosis of stricture. A catheter is generally preferable for *that* purpose; as not unfrequently the patient first seeks relief when suffering from an attack of retention, and the Surgeon having succeeded in getting an instrument into the bladder, may be very glad to leave it there. Hence, also, a catheter is generally most suitable in the *commencement* of treatment.

The introduction of a catheter may be performed in either of the two ways already described, and according to the directions given. An instrument of such *size* only should be used as shall be found to enter the stricture easily, and can pass fairly through it without feeling tightly held by the contraction. Dilatation is then effected by leaving the instrument in this contracted portion of the canal; so as to continue the slight expansion, and induce absorption of the plastic deposit in the mucous and submucous tissues forming the stricture. The proper *period* for maintaining the dilatation is, in my judgment, about five minutes,—some say twenty minutes; then the instrument should be withdrawn, and its size or number noted as a standard of comparison in the subsequent introduction of gradually larger-sized instruments. Professor Spence's three recommendations are, I am sure, here advisable :—always pass the size of instrument used on the previous occasion, before proceeding to the next larger size ; never omit any one size to pass a higher one ; never pass two larger sizes on the same occasion. By disregarding either of the two latter rules, undue irritation will almost certainly be excited, and the Surgeon is more likely to lose than gain ground. An instrument may be *re-introduced* every two or three days. But the intervals of catheterization must be regulated by the state of the urethra, and the constitutional disturbance induced. When bleeding, pain, or smarting in micturition follow or continue after the operation—events very likely to happen after the first passage of an instrument through the stricture—further dilatation must be postponed for a day or two, until this urethral condition has subsided. Rigor or shivering, faintness or sickness, may also supervene, especially under similar circumstances ; postponing any re-introduction of an instrument until this state of constitutional disturbance has passed off. Chloroform, therefore, often becomes an invaluable agent in the treatment of tight stricture by dilatation. Spence is inclined to believe that rigor arises from the irritation produced by the instrument in passing over the prostatic urethra and neck of the bladder. Hence, in using the smaller-sized instruments, when the flow of urine shows that the bladder is entered, the catheter should be withdrawn, and left only in the stricture ; or in using those of larger size, the instrument is passed only through the stricture, and no farther.

Flexible and *Elastic Bougies* are now much employed as a substitute for catheters—metallic or gum-elastic,—in the treatment of stricture by dilatation, as well as in the diagnosis of stricture. These instruments owe their advantage not only to their flexible and elastic character, but also to the peculiar shapes of their distal extremities. The forms more commonly employed are—the *bougie olivaire*, having an olive-bulb end, whereby the instrument can be insinuated or twirled into a stricture, aided by the flexible nature of the shaft, without the liability of making a false passage; the *bougie conique*, having a conical tapering point, can enter a stricture more readily, but it is liable to lodge in a lacuna and make a false passage, which is prevented by the olive; the *bougie olivaire à ventre*, having a spindle-shaped enlargement above the olive end, thus specially dilates the stricture, and up to the largest-sized catheter without painfully distending the comparatively narrow external meatus of the urethra; the *bougie conique à ventre* is similar to the last, and used for a similar purpose, but its conical end has some disadvantage relative to the formation of false passage; the *bougie à trois nœuds* having three conical enlargements, of successively increasing size, this instrument is specially suitable for rapid dilatation.

For very tight strictures, the *filiform elastic* bougie may be twisted through the urethra, inch by inch from the glans, any obstruction being indicated by the shaft of the bougie springing back, until it is arrested and held in the stricture. The *olivary whalebone* bougie, though almost filiform, is much stiffer, yet, being provided with an olive end, is safe in its passage ; this instrument thus seems specially suited for very tight, indurated, and perhaps extensive stricture, as when of traumatic origin. Elastic instruments were originally introduced into surgery by Bernard, a French goldsmith, who brought them before the Academy in 1779. Recently they have come into general use in America; and in this country principally by the advocacy of Mr. Teevan.

This plan of treatment—by gradual dilatation—must be prolonged until the urethral canal is restored to its natural size, and the stream of urine fully established. The urethra may then admit a catheter of full size—No. 12—or a bougie of equal size, with ease; when it should be passed less frequently, once in a week or ten days. Lastly, it will be necessary to maintain the patency of the canal, by an occasional use of the instrument once in a month or six weeks.

In the course of treatment by dilatation, the general health should be attended to; especially with regard to the digestive organs, and the state of the skin and kidneys.

Continuous dilatation may be advantageously resorted to when the stricture proves *obstinate* under the ordinary plan of gradual dilatation. The principle is that of rapid dilatation and dissolution of the stricture, by retaining the instrument in the contracted portion of the canal for a period varying from forty-eight to seventy-two hours at a time. The catheter is fastened by means of tapes passed through the eyes of the instrument, on either side, and thence under the buttocks and over the thighs to a waist-band. If a gum-elastic catheter be used, it can be secured by a strip of adhesive plaster to the penis. A peg of wood or bit of cork is inserted into the orifice of the catheter, and the water drawn off as occasion requires.

In the management of this process, three points must be observed:—the catheter should occupy the stricture, without fitting tightly or being grasped by it; the instrument, when tied in, should not project against the interior of the bladder; and after using a silver instrument on the first occasion, the succeeding instrument may be gum-elastic, as causing less irritation.

When, in about forty-eight hours, the catheter has become loosened in the stricture, and a slight purulent discharge has taken place around the instrument, it should be withdrawn. In two or three days, this procedure is renewed, and an instrument larger by two or three sizes may be at once introduced; and so on until a full-sized one can be passed easily. Recontraction must then be prevented by occasionally passing an instrument, at gradually increasing intervals of time.

Difficulties and Accidents in Catheterism.—*Induration* or hardening of the stricture sometimes presents considerable difficulty to insertion of the point of the instrument. This may perhaps be overcome by using a conical-pointed elastic catheter, or bougie. But, if the stricture be not very sensitive, continued pressure on the face of the induration will probably cause the stricture to yield. Injecting the urethra with four or five drachms of olive oil seems to exercise an hydraulic pressure on the stricture by penetration of the fluid into the narrowed passage.

Spasmodic action must be overcome by the means appropriate for spasmodic stricture.

False passage.—A false passage, or a passage leading out of the natural urethral canal, is made by forcible and misdirected pressure with the point of any instrument in its course through the urethra. The passage, therefore, usually takes a direction downwards and backwards, and to one side of the urethral passage; in an opposite direction to the stream of urine, the free discharge of which remains unaffected. An inflexible instrument, as the ordinary silver catheter, will be more apt to cause this misadventure than a flexible instrument; but the latter is more liable to enter a false passage already existing.

The previous existence of such a passage or passages is perhaps the most common and perplexing occasion of difficulty in using an instrument; and its production, an accident most to be avoided. The importance of these considerations in relation to catheterism, lies in the fact that the difficulty of entering the right opening is increased by the facility with which the instrument slips into the wrong one.

A false passage varies in its *situation* and *extent*. When the stricture is far forwards, the passage may run into the corpus spongiosum; when further backwards, in the usual situation, the passage may perforate either lateral lobe of the prostate (Fig. 920), or run up between it and the rectum (Fig. 921); this latter direction being especially dangerous. The *floor* of the urethra is most commonly the seat of a false passage; and it is most liable to happen in connection with a tight stricture, and the introduction of a small-sized instrument.

Fig. 920.[*]

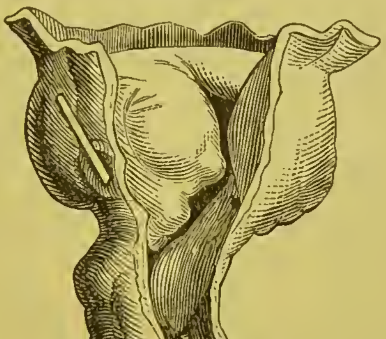
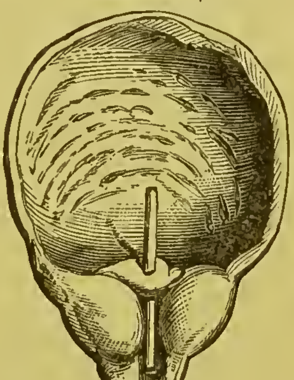


Fig. 921.[†]



Hence, in the treatment of such a stricture more particularly, and when it has been subjected to the previous use of instruments, an important practical injunction in passing the catheter is this—the point of the instrument should be kept against the roof or *upper surface* of the urethral canal.

Certain *signs* at once indicate to the Surgeon that a false passage has been commenced, or entered if pre-existing. The point of the instrument is felt to make a sudden slip, and the shaft inclines to one side of the urethra; the point also feels free and movable, and communicates a rough or grating sensation, while it can be easily withdrawn; all these peculiarities being more notable when occurring after the instrument had been felt to be held or grasped by the stricture. The patient experiences sudden and severe pain, and is often conscious that something has given way; on withdrawing the instrument, it is found besmeared with blood, and there will be free hæmorrhage from the urethra, with perhaps, as I have noticed, some degree of turgid priapism. But an *old* false passage, with consolidated walls, will communicate the same sensation as if the instrument were passing through a stricture, and is unattended with pain or hæmorrhage; the only obvious sign, perhaps, being some deviation from the natural direction in the course of the urethra.

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[*] Roy. Coll. Surg. Mus., 2508. (Liston.)

[†] St. Mary's Hosp. Mus., H. *h*. 25. False passage, or tunnelling, through enlarged middle lobe of prostate, this passage commencing from the membranous urethra; there is also another false passage almost opposite the bulb. (William Coulson.)

To avoid accidentally dilating a false passage, instead of the urethra, it has been proposed to pre-occupy that passage with a fine probe-pointed whalebone bougie, before using the urethral bougie; a practice chiefly in vogue among continental Surgeons. Thus, one of the fine bougies is slid along the urethra, and if it slip into a false passage, it is left there; a second and a third such passage may perchance be pre-occupied in like manner; then, the urethral bougie can be thus guided almost with certainty into and through the stricture. This resource would seem to be suitable only in the dilatation of a tight stricture, and when the false passages are not more in number than for the urethral canal to accommodate the fine bougies as well as the dilating instrument; and in thus taking possession of existing false passages, care must be taken not to make fresh ones!

Hæmorrhage must be regarded as another accident attending catheterism; but it is also liable to occur independently of any urethral lesion, from the mere passage of an instrument, in inflammatory stricture.

Inflammation affecting the urethra or testes may be induced by dilatation; especially with instruments of too large a size, or rapidly increased.

Other evil concomitants, or consequences, have already been alluded to; pain in micturition, rigors, faintness, sickness.

Gradual dilatation having proved ineffective for the cure of stricture, other methods of treatment must be resorted to; and they are especially applicable, when either the sensitive state of the stricture or its contractile and recurring tendency would render that mode of treatment inapplicable, as being intolerable or unsuccessful. The degree of *tightness* of the stricture and the amount of *induration*, together representing an undilatable state of stricture, will be found to determine the particular mode of treatment then to be adopted—whether Forcible Dilatation or Rupture, or Division by incision, internally or externally.

IMMEDIATE AND FORCIBLE DILATATION, OR RUPTURE.—In estimating the applicability and advantage of this method of treatment for stricture of the urethra, it would certainly appear that the vital character and constitutional relations of the urethral tube should forbid any dilatation of an immediate and forcible character; and still more so any rupture of its component tissues. Yet experience has now shown that not only may this mode of treatment be practised with impunity; but that a tight stricture, undilatable gradually beyond a certain degree, and any further distension of which would excite severe constitutional disturbance, can be forcibly dilated or ruptured up to the natural size of the urethra and without producing any such symptoms.

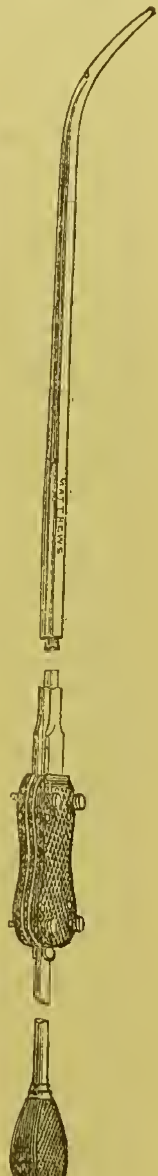
Forcible dilatation is effected by means of *distending instruments*, which when passed through the stricture exert an expanding force from within outwards. Such force may be accomplished by a *series* of instruments, consisting of sliding tubes, passed successively over a slender urethral director or guide, which is first passed through the stricture; or, it can be effected by means of a *single* instrument which expands *in sitû.*

Sliding tubes were originally employed by Desault (1797), and afterwards by Dr. Buchanan, of Glasgow (1831), Dr. Hutton, of Dublin (1835), and by Maisonneuve (1845). Mr. Thomas Wakley, with whom this mode of treatment was originally identified in this country, contrived a series of accurately fitting tubes and a urethral director. This having been first passed through the stricture, each sliding tube, in succession, cannot fail to take the same course. The difficulty, and the risk, will always be to first introduce the slender director through a tight stricture; a difficulty proportionate to the degree of contraction, and the existence of false passages, or the liability of making them. *Single* instruments of various kinds have been devised, which expand *in sitû*, in the place of several instruments of increasing calibre; and thus save the necessity of passing them successively through the constricted part of the urethra. With this object, Mr. Luxmore (1812) employed diverging metal rods; Leroy d'Etiolles the same method, some years later, and Perrève a somewhat similar plan (1847). Dr. Neil Arnott, on the same principle, commenced the employment of fluid expansion (1819). Both these forms of contrivance —the series of sliding tubes and the single expanding instruments—have a similar action upon the urethra,—distension of the contracted portion from *within* its area. They thus differ from the large conical metallic bougie formerly used for the purpose of forcible dilatation, which was driven into the stricture; thereby running the risk of pushing the stricture down the canal and detaching its connections, and inevitably inducing inflammation and severe constitutional disturbance.

Rupture or Splitting of the Urethra.—Mr. Holt has recently revived this mode of forcibly opening stricture of the urethra. It seems to be most applicable to tight stricture, *without* much induration; so that the plastic deposit does not form a mass too thick or dense to be entirely ruptured. Rupture may, therefore, possibly supersede the necessity for division by a cutting operation.

The "dilator" (Fig. 922) used by Mr. Holt is precisely similar to that of Perrève. Its construction, and his mode of operating, he thus describes:—The instrument consists of two grooved blades fixed in a divided handle, and containing between them a wire welded to their united point; on this wire a tube — which when introduced between the

Fig. 922.



blades corresponds to the natural calibre of the urethra—is quickly passed, and thus ruptures or splits the obstruction. Having introduced the instrument, and reached the bladder, it should be gently rotated, to prove that the end is fairly within that viscus; and being thus assured, the Surgeon is next to place the point of the tube he had previously selected, upon the wire between the blades, and thrust it quickly onwards to the end. The stricture being now fairly split, the dilator should be rotated, to still further separate the sides of the rent, and then be withdrawn; a catheter, corresponding to the number of the tube, being substituted for the purpose of removing the urine. The catheter is then withdrawn, the patient treated with quinine and opium for the first twenty-four hours; and the same catheter introduced occasionally perhaps during that period, to prevent any risk of urinary infiltration in micturition; or in forty-eight hours, to maintain dilatation; and again on alternate days for a week or two, gradually lengthening the interval. Voillemier's instrument differs from Holt's in an important particular: the tube is provided with lateral grooves, so as to slide along the blades, instead of upon a central wire-conductor; the expanded instrument thus assumes a circular, instead of an oval form, whereby the dilating force is expended *equally* upon the whole circumference of the urethral canal.

The *results* of this procedure in the hands of Mr. Holt have been eminently successful; and the experience of other Surgeons has generally confirmed its value. I have not seen much constitutional disturbance follow the operation of splitting the urethra; but in one case, operated on in another Hospital, extravasation of urine ensued, for which I treated the patient at the Royal Free Hospital, and he recovered. Many deaths, however, have, I believe, occurred,—Mr. Teevan says fifteen in number, which have not been recorded in the Reports of Cases hitherto published. It would also be very desirable to diagnose more correctly the *pathological conditions* of stricture operated on,—if indeed they can always be determined clinically; since it will be obvious that the mere splitting up a number, say some scores, of urethræ, many of which were perhaps scarcely strictured at all, can have nothing to do with the propriety or eligibility of this mode of treatment. The splitting of urethræ, in almost a *healthy* state, would necessarily swell the resultant proportion of, apparently, successful cases. I do not apply this remark to Mr. Holt's cases, but to an extraordinarily large series which has been published.

Sir H. Thompson has contrived a screw-*distending* instrument for this operation, and it seems to possess three advantages:—distension of the stricture *alone* is accomplished, without involving the healthy portion of the urethra in its action; the distension, as indicated by the scale near the handle, can be carried to a calibre of 14 or 16 of the catheter scale, beyond the size which the external meatus will admit, and is thus more efficient; and the distending force is applied very slowly, continuing from seven to ten minutes before reaching the maximum point of distension,—the object being to overstretch the morbid tissues as much, and to rupture them as little, as possible, in order to destroy, or greatly impair, the natural tendency of the stricture to undergo contraction.

Another screw-distending instrument, devised by Dr. J. Thebaud, of New York, is worthy of notice. The terminal portion consists of two blades, which can be separated to such an extent as to rupture the stricture. Distension or rupture, as thus effected, involves more than the constricted part of the canal,—a disadvantage compared with Thompson's instrument; while—relative to Holt's dilator—Thebaud's instrument has the disadvantage of being too large-pointed for tight strictures; but the special advantage of carrying distension to any known *degree* is supplied by the index near the handle.

Strictures of *very* tight character may be penetrated by a filiform bougie guide, adapted to the end of any such instruments; an addition originated by Van Buren, and completed by Charrière.

Caustics.—Cauterization, in the treatment of stricture, has been practised with two objects in view: the deadening of sensibility or spasm, and the destruction of induration; in both ways permitting subsequent recourse to dilation. For the former purpose, cauterization may be of some use. It can be effected by the introduction of an instrument armed with caustic, such as nitrate of silver or potassa fusa, which is carried down to, and allowed to rest against the stricture for two or three minutes. A gleety discharge is thus established, and the caustic may be reapplied every two or three days until a catheter can be passed, and gradual dilatation made to complete the cure.

This method of treatment was formerly in vogue, and still, I believe, has one or two advocates in this country, principally the late Mr. Wade, and less urged by Mr. H. Smith; but the experience of the best Surgeons, both here and in France, has condemned it, as being both perilous and extremely uncertain in its results. Stigmatized by Mr. Liston as "most atrocious," and discountenanced more recently by Nélaton, the cure of stricture can always be accomplished more safely, and with greater probability of non-recurrence, not to mention the liability of making a false passage. Cauterization has, therefore, now fallen into general disuse.

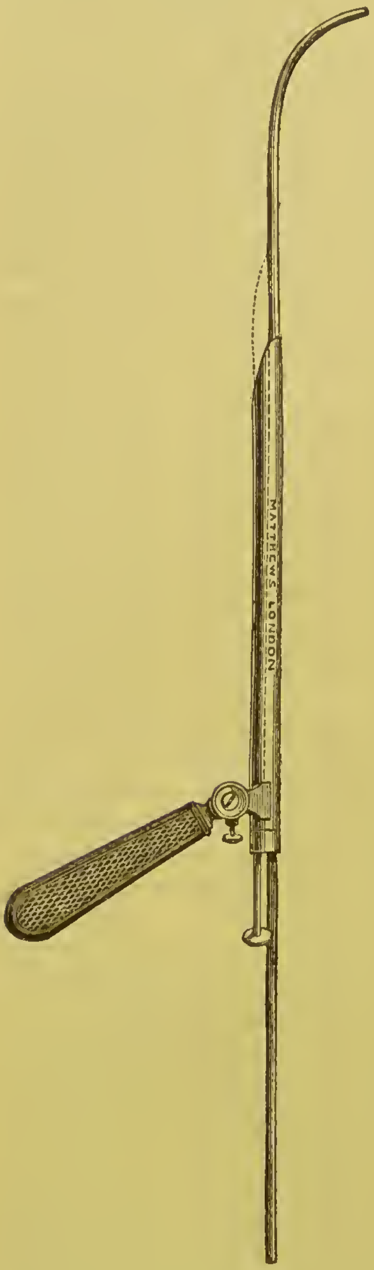
Division of the Stricture.—Section of the urethra may be resorted to in tight stricture, with considerable induration, forming a hard and large *nodule*, unfitted for rupture; and accompanied perhaps with much sensitiveness and irritability, or contractility and resiliency—conditions which are also unfitted for gradual dilatation. The incision is made, either from within the urethra, or from without, and usually in the perineum.

(1.) *Internal Urethrotomy.*—Division of the stricture from within the urethra has been practised for above a century. Allies of France (1755), Physick of Philadelphia (1795), John Bell (1806), and his brother Charles Bell (1807), M'Ghie (1823), and Stafford (1827), have severally advocated this method of treatment. It has been practised extensively in France, especially by Civiale; and occasionally by modern Surgeons in America and in this country.

The operation may be performed in two ways:—*incision from before backwards*,—section being made by pushing downwards a lancet-like blade, generally with a slender conductor in advance of it, into the obstruction to be divided; *incision from behind forwards*,—a portion of the instrument containing a small blade, sheathed, is first carried down through the stricture, which is then divided by protruding the blade downwards and withdrawing it, in the floor of the urethra, through the whole of the contracted portion, with a little of the sound urethra in front and behind, but taking care not to incise too freely in depth.

Thus, the length of this incision may be from one to two inches, while its depth should not exceed more than half that to which the blade can be projected in Civiale's instrument. The penis should be stretched to steady the otherwise movable urethra. Of the two methods of operation, the former is suitable for antibulbous strictures, the urethra being straight in that portion of its course, is not liable to perforation; deeper strictures, situated in the curve of the canal, had better be incised from behind forwards. Various instruments, or *urethrotomes*, have been constructed for the internal division of strictured urethra. For incision from before backwards, Stafford's lancet-catheter may be used; the point is concealed in the tube until the end of the instrument rests upon the stricture, it is then projected, and the instrument carried on through the obstruction. A curved, as well as the straight, form of this instrument has been employed. Sir H. Thompson's catheter-urethrotome or Mr. John Wood's instrument (Fig. 923) is more applicable; also the urethrotome with terminal fine bougie guide, devised by Maisonneuve, or the similar shielded instrument of Voillemier. For incision from behind forwards, Civiale's urethrotome is the best form of instrument. Trélat's urethrotome can be used in both ways,—from before backwards, and then from behind forwards; thus making a second incision when necessary, and the operation more complete. After either mode of operation, a full-sized catheter should be introduced along the roof of the urethra, to avoid the incision, and retained for twenty-four hours; although some Surgeons of experience think the latter practice unnecessary or objectionable. An instrument should also be passed occasionally, for some time, to prevent recontraction. A urethrotome provided with a terminal filiform bougie, will enable the operator to deal with *very* tight strictures.

FIG. 923.



The immediate effects and after-consequences of internal urethrotomy are very seldom serious. Hæmorrhage, beyond a few drops of blood, is rare, and easily stopped by passing a full-sized instrument, and the application of ice externally. Some feverishness often ensues, but soon subsides. Abscess and extravasation of urine are very uncommon, having taken place once or twice only in nearly 200 cases operated on by Sir H. Thompson; while cystitis, nephritis, and pyæmia are unknown.

The *results* of internal urethrotomy are also satisfactory, as regards the immediate restoration of the urethral canal to its natural calibre; the ultimate result may be permanent, or evince a tendency to the return of stricture,—generally, however, amenable to dilatation. It should also be observed that in both modes of internal urethrotomy, the strictured portion of the canal must be generally large enough to admit an instrument equal in size to a No. 4 or 5 catheter; and that with this degree of patency, it may well be considered probable that further and perhaps complete enlargement might be accomplished by dilatation. I very rarely find it necessary to have recourse to internal section of the urethra. But the operation is at least a safe procedure; only one death having occurred in the above series of 200 cases.

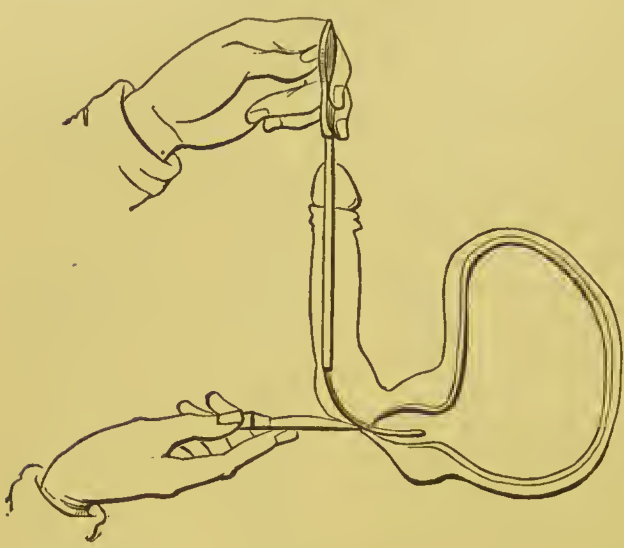
(2.) *External Urethrotomy.*—Division of the stricture by external incision is an alternative operation of urethrotomy, the earliest instance of which, for the cure of stricture, is recorded by Wiseman (1652). A few years afterwards, Solingen, at Livourne, adopted this procedure; followed by François Tolet and Colet (1690). J. A. Petit and Le Dran (1740) had recourse to a similar operation; and John Hunter (1783) performed the operation now known as the perineal section; but it was rarely employed until advocated by Mr. Grainger, of Birmingham (1815), and afterwards by Mr. Arnott. These operations refer to cases in which no instrument could be passed through the stricture. More recently (1844), Mr. Syme has advocated external division of the stricture in cases where, although a catheter can be passed, no other treatment has afforded sufficient or permanent relief.

Perineal section, as the operation of external division of the stricture may be generally designated, is applicable in two degrees of extreme urethral contraction:—permeable stricture, through which a slender grooved staff can be passed, and the external incision made upon this instrument; and impermeable stricture, through which no instrument apparently can be passed, the only guide being a full-sized instrument passed down *to* the stricture, towards the point of which the external incision is directed.

The condition of stricture appropriate for perineal section is that of considerable, even cartilaginous, induration, both in *thickness* and *extent*, appreciable usually by external examination with the finger; coupled perhaps with perineal fistulæ, either chronic or numerous.

(*a.*) *Permeable Stricture.*—Perineal section, by Syme's operation, is performed as follows:—The instruments required are—a staff, slender, slightly curved, and well-grooved in its lower half, and the upper of full size; a pointed scalpel; a broad director; and a silver catheter, No. 8 or 10. The staff is passed *through* the stricture, so that the shoulder or termination of the upper thick portion rests against the upper part or face of the stricture. The patient is tied up as for lithotomy, and the staff held in like manner by an assistant, with the scrotum drawn forwards. The Surgeon, sitting in front, makes an incision in the raphé or median line of the perineum, about two inches in extent, and proceeds cautiously straight to the shoulder of the staff, feeling his way with the forefinger of the left hand. Having clearly reached that point, he takes the staff from the assistant in his left hand, and enters the point of the knife in its groove, *behind* the stricture (Fig. 924); thence cutting upwards to the shoulder of the staff until it can be passed onwards into the bladder. This instrument is then withdrawn, and the No. 8 catheter introduced and retained for forty-eight hours. Subsequently, a full-sized catheter should be passed every three or four days, and afterwards at longer intervals, to prevent recontraction. Difficulty in introducing the catheter, after withdrawing the staff, may be obviated by first passing the director into the urethral wound, along which, as a guide, the catheter glides into the bladder. Instead of using a catheter, Mr. Syme prefers at first to pass a tube through the incision into the bladder, in order to guard the wound as much as possible from contact with urine. Hæmorrhage rarely proves troublesome immediately after the operation, or subsequently; and it can be stopped by careful plugging of the wound, then placing a compress over it, and retaining the whole in position by a T bandage,—a catheter being kept in the bladder.

FIG. 924.



The following directions are given by Mr. Syme, as essential to the success of this operation:—(1.) Maintain the median line in the incisions. (2.) Make a direct opening down to the staff, not a tortuous one. (3.) Divide the whole of the contracted part, rather more than less. (4.) Do not cut so far back as to endanger the deep fascia of the perineum, and use the knife in the deep incisions with the cutting edge uppermost. (5.) Do not close the end of the inlying catheter, lest urine be forced into or through the wound, for want of patency in the instrument. (6.) Avoid escape or displacement of the instrument. (7.) If incisions are made far back, introduce a curved tube through the wound when the catheter is withdrawn. (8.) Do not neglect dilatation during the progress of recovery.

(*b.*) *Impermeable Stricture.*—This condition of stricture is very rare, if it ever exists. As Syme justly observes, any stricture, through which urine can escape, will admit an instrument to be passed with care and patience. Then, of course, the operation may be performed as for permeable stricture. Otherwise, a catheter of full size having been passed down *to* the stricture, and held there firmly by an assistant, perineal section is performed; the point of the instrument being the guide to, but not through, the stricture. Having clearly reached that point, the Surgeon endeavours to pass a small grooved director through, or partly through, the stricture; and on this instrument he at once divides, or successively pursues, the tract of the contracted canal. When no director, however small, can be introduced, the urethral canal must be followed without any such guide, by dissection alone cautiously conducted. In either case, as soon as the continuity of the passage is restored, the catheter above is to be carried on into the bladder, and retained in the usual manner for a period of some days.

Results of Perineal Section.—The latter operation of external incision—without a urethral guide—is of course hazardous and uncertain in its results. But perineal section, as performed on a grooved staff, has yielded excellent results,—in a suitable condition of stricture, and when the operation has been properly performed. Among 219 cases collected with scrupulous care by Sir H. Thompson, there was a mortality of between six and seven per cent. Of this percentage, nearly two-thirds died of pyæmia; the remainder, one or two only excepted, from fever and suppression of urine. Such a mortality is not large, considering the extreme cases of stricture and broken constitution subjected to the operation. Neither hæmorrhage nor urinary infiltration ranks as a cause of death from perineal section. But the stricture almost always returns, unless catheterism or the passage of bougies be practised, occasionally, for some time after recovery from operation.

The *pathological conditions* of stricture submitted to operation will of course materially affect the proportionate result of apparently successful cases. Perineal section is appropriate for the condition originally proposed—an almost impermeable stricture, and which is otherwise incurable by dilatation,—and this is always implied, when *properly* speaking of the operation and its results; but I have seen perineal section performed when, at the time of operation, a full-sized catheter had just before been passed, easily, into the bladder,—and the operation having been performed simply for extravasation of urine.

SPASMODIC STRICTURE.—This kind of stricture is due to the spasmodic action of the muscles surrounding the urethra, and is of a temporary character. It rarely occurs alone, but usually as a supervention on organic stricture, or in connection with an inflamed state of the urethral canal. Spasmodic stricture may occur at any portion of the urethra, by contraction of the layer of involuntary muscular fibres which encircle it throughout its course; or the membranous portion of the urethra may be constricted by spasm of the compressor urethræ muscle, acting as a sphincter on this portion of the passage, and this is the usual seat of a spasmodic stricture of the urethra.

The symptoms are those of obstruction to the passage of the stream of urine, but of temporary duration, although perhaps oft-recurring. They thus differ from the same symptoms in organic or permanent stricture.

Local and urethral conditions, or remote and constitutional conditions, may severally give rise to spasmodic stricture. The first class comprises, principally—the presence of organic stricture; of inflammation from suppressed gonorrhœal discharge; irritation of the urethral mucous membrane from various states of the urine, especially a highly acid state,—in various constitutional conditions, as gout; foreign matters ingested and expelled by the urine, as cantharides, turpentine, condiments, alcoholic drinks; and the voluntary retention of urine for too long a time. The second class of causes includes, chiefly—rectal irritation; as from hæmorrhoids, fissure, prolapsus, fistulæ, operations on the rectum, ascarides, and anal prurigo; derangements of the digestive organs, and of the cerebro-spinal system. The *social* circumstances under which the practitioner will commonly meet with spasmodic stricture are characteristic. As affecting the more affluent classes of society, the indulgence overnight of acid wines, punch, or stimulating food and condiments, at supper-parties or convivial meetings, may be followed next morning by an attack of spasmodic stricture, especially in persons of a gouty diathesis. The restraints of society with regard to the retention of urine, the outdoor amusements of hunting, steeplechasing, or other rough riding across country, are also circumstances under which spasmodic stricture is liable to occur. Or the picture may be reversed; the combined effects of cold and exhaustion drive many a homeless wanderer to seek relief at an Hospital during the early hours of our winter mornings. The anxiety and harass of business, the pressure of over-study, or of writing against time in newspaper offices, etc., not unfrequently subject the commercial and the literary classes of society to the penalty of an attack of urethral spasm.

Treatment.—The cause of spasm must be sought, and if possible removed. In an attack of spasmodic stricture, remedial measures should be directed to the relaxation of the muscular contraction. The most effectual antispasmodics are a warm bath, and a full dose of opium,—the tincture or Battley's sedative. I have used a drachm or more of the compound tincture of camphor with advantage. Chloroform, inhaled, has sometimes afforded instant relief. Suppositories have not had much effect. This antispasmodic treatment is most successful when the stricture arises from exposure to cold. But if the gouty diathesis prevails, or the circumstances of origin point to acidity of urine, then alkalies and other appropriate remedies must be combined. Catheterism should be avoided as long as possible, the introduction of an instrument tending to provoke spasm; and when resorted to, the catheter used should be full-sized, or at least one of the higher numbers.

INFLAMMATORY STRICTURE.—An inflamed or congested state of the urethral mucous membrane may occasion a species of temporary stricture. It is less an independent condition, than engrafted on a pre-existing organic stricture, or coincident with spasm.

The symptoms are somewhat peculiar. In addition to obstructed micturition, the penis is turgid and erectile, and the urethra bleeds freely on the introduction of even a moderate-sized catheter; there is intense scalding in passing urine, and the stream narrows rapidly during the act, ceasing abruptly before the bladder is emptied. The urine is, as it were, shot out at short intervals from the bladder, itself in an irritable state. Perineal heat, fulness, and tenderness are complained of, when the inflammation extends far back. In all these respects, inflammatory stricture contrasts with that produced by spasm.

As causes of this kind of stricture may be mentioned retrocedent gonorrhœa, or suppression of the discharge by exposure to cold or wet, or by an inconsiderate recourse to injections during the inflammatory stage. Indulgence in alcoholic liquors or a stimulating diet will also contribute to the inflammatory or congested state of the urethra.

Treatment must be conducted on ordinary principles. This urethral condition resulting usually from suppressed gonorrhœa, it will subside on the reappearance of the discharge. Wrapping the penis in a poultice is a simple remedy which I have often found successful.

TUMOURS IN THE URETHRA.—Growths within the urethra, formerly known as "caruncles" or "carnosities" and supposed to be common, are extremely rare. Their nature, according to Sir H. Thompson's careful examination of recorded cases, seems to be of three kinds: vascular granulations, situated generally near the external meatus, or projecting; polypoid formations, peculiar to the prostatic part of the urethra; masses of tubercular and cancerous origin. Both the latter forms of deposit are rarely primary in the urethra, but secondary to disease of the kidney, bladder, or prostate; and they seldom appear until the primary disease is far advanced. Either sex is liable to these tumours.

The *endoscope*, an instrument for inspecting the urethral canal and the interior of the bladder, may afford some aid in detecting and diagnosing urethral formations. Originally suggested by the late Mr. Avery, the instruments devised by Desormeaux, Cruise of Dublin, and Wales of Philadelphia, are more or less useful; Wales's endoscope having the advantages of simplicity and cheapness.

The local importance of any such urethral tumour is the degree of obstruction thus offered to the free passage of urine, as a cause of retention.

Treatment.—Urethral growths may be removed on the same principles as similar tumours in other parts—by Excision, Ligature, Caustics, or the Actual Cautery. Excision can generally be accomplished by means of scissors, aided by dilatation of the urethra. In this way I have succeeded, especially as regards the female urethra, in removing vascular and erectile growths, which, although not of larger size, were very troublesome. Ligature is difficult, painful, and tedious; unless the growth be polypoid, when it may be looped with silver wire. Caustic applications, as nitric acid or potassa fusa, can scarcely be restricted in their action to the growth alone; and the actual cautery by means of the galvanic wire will be preferable.

Calculus in the Urethra.—Urethral calculus is generally derived from the kidney and bladder, or from a fragment of stone becoming arrested in some part of the canal; but rarely the calculus forms within the urethra, by deposit in the sacculus or dilatation behind a stricture. Here urine constantly collecting may give rise to concretion, or it forms around a particle of calculous matter as a nucleus.

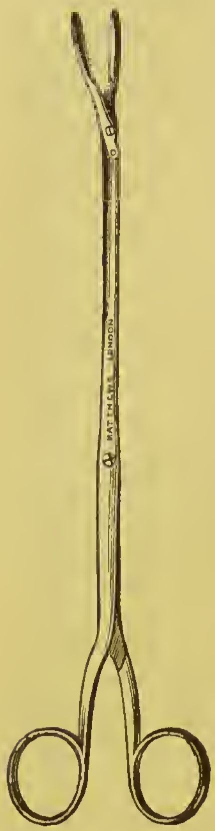
The calculus is usually of the lithic acid variety; it more than occupies the calibre of the canal transversely, and assumes an elongated form; it may attain to a very large size. Several calculi are sometimes present; small, smooth, and faceted.

The symptoms are obvious; frequent and difficult micturition, bordering on retention; and the stone may be felt externally in the perineum or detected by introducing a sound, which at once strikes against the calculus, or grates roughly over it when imbedded in a dilated portion of the urethra. Rectal exploration with the finger is often serviceable. Care must be taken, in either case, to guard the canal on the vesical side with the finger, lest the stone be pushed back, or might slip back into the bladder. Pain in the situation of the calculus is sometimes experienced, especially if the stone be rough, and movable in the act of micturition; but not unfrequently there is no such symptom, and the calculus lies singularly quiescent and unsuspected.

Ulceration and abscess are liable to ensue, resulting in extravasation of urine, and urinary fistula.

Treatment.—The calculus may perchance be expelled in the passage of a full stream of urine. Hence, the Surgeon sometimes avails himself of this natural mode of cure, by directing the patient to retain his water as long as possible, and then to compress the urethra with his fingers in front of the calculus when he endeavours to micturate; the stream of urine, coming out suddenly with a forcible gush, carries before it the stone. The removal of a urethral calculus must, however, generally be effected either by extraction or by incision. When situated in *front* of the scrotum, the calculus can often be extracted by passing down the urethra a long, slender, urethral forceps (Fig. 925), aided by moderate dilatation; or, failing thus to remove the stone, it should be pushed back into the perineum, and then removed by incision, any incision of the urethra in front of the scrotum generally resulting in a fistulous opening. A stone lodged in the navicular fossa near the meatus, may be eased out by dilatation; or by a slight incision of the orifice with a probe-pointed bistoury, which I disapprove of as liable to induce stricture.

Fig. 925.



When the calculus is situated in the *perineal* portion of the urethra, or has been pushed back to that part, it should be removed by a clean median incision on a grooved staff—external urethrotomy—at the same time compressing the urethra firmly with the finger behind the stone, lest it accidentally recede into the bladder. If this happens, a long pair of slender forceps can perhaps be introduced and the stone extracted. After the perineal section, there is little risk of urinary extravasation, and less of fistula or of stricture resulting.

In the *membranous* or *prostatic* portions of the urethra, an impacted calculus may admit of extraction by the median operation of lithotomy. Or, the stone can be pushed back into the bladder, either by means of a large-sized catheter, or by urethral injection. It may then be removed by lithotrity or lateral lithotomy.

Foreign bodies of various kinds have been introduced into the urethra by persons, to gratify some morbid curiosity or prurient feeling; and any such body having slipped out of reach, surgical assistance becomes necessary. Thus, a *hair-pin* has been passed into the urethra, and the ends expanding and sticking in the mucous membrane, they cannot be secured with forceps. But if the pin be compressed through the urethra, with the thumb and finger, a small thin tube may be slid over the ends of the pin, which can then be extracted through the tube.

RETENTION OF URINE.—This term is understood to signify an inability, arising from various causes, to pass any urine, or only a very small quantity. It thus differs from the partial retention of urine in engorgement of the bladder with occasional overflow, and which is dependent on enlargement of the prostate. Moreover, the one is a recent or acute condition, the other an habitual or chronic condition.

The symptoms are not only an absence of micturition, or the escape of urine by drops after much straining and painful effort; but also, as the bladder becomes distended and rises above the pubes, there is dulness on percussion over that region, extending upwards at length perhaps to the umbilicus. This is accompanied with much distress and constitutional disturbance.

Various causes may give rise to retention of urine, but they are all reducible to two classes: that of *defective expulsive power*, in *paralysis* involving the abdominal muscles and bladder; and that of *obstruction* to the passage of urine, as dependent on *prostatic enlargement* from any cause,—inflammation, chronic hypertrophy, or tumour of a sufficient size to block up the internal meatus of the urethra; *perineal abscess*, occasionally; *stricture of the urethra*, organic, spasmodic, or inflammatory; *urethral tumours*, *calculi*, or other foreign bodies in the urethra, occasionally.

Unrelieved retention of urine leads generally to *rupture of the urethra*, and especially when the source of obstruction is in the urethra, the canal yielding behind that point, and this event being followed by extravasation of urine; rarely, *rupture of the bladder* occurs in consequence of retention.

Treatment.—Retention of urine must of course be regarded with reference to the removal of its cause; but the bladder admits of being entered, and the accumulated urine drawn off, in five different ways:—(1) by catheterism; (2) incision of the urethra through, or behind, the obstruction, usually in the perineum; (3) puncture of the bladder through the rectum, (4) above the pubes, or (5) through the symphysis pubis.

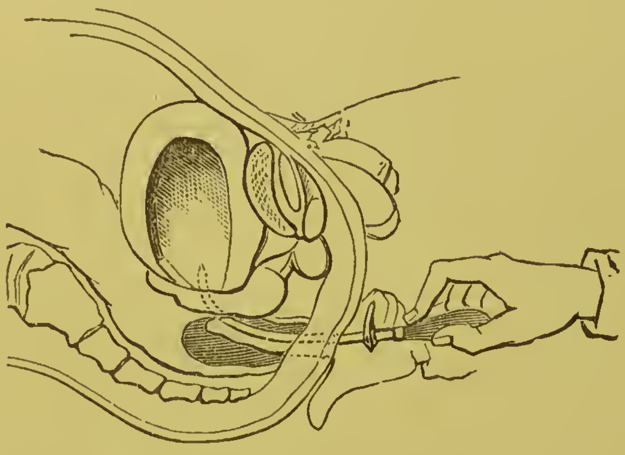
Catheterism.—This mode of gaining admission to the bladder will usually succeed, in conjunction with the treatment for any temporary spasmodic or inflammatory obstruction, which may have become engrafted on an *organic* stricture, from some excess or from exposure to wet or cold—the circumstances under which retention generally arises. Accordingly, a small-sized catheter is selected, about No. 4 or smaller, silver or gum-elastic; and the instrument introduced with due attention to gentleness, caution, and patience. The stricture may often yield more readily than might have been anticipated, when retention is present, owing to the dilatation effected by the pressure of urine above; or on withdrawing the instrument from just the entrance of the stricture, the urine will often follow in a full stream. If the Surgeon fails in thus affording relief by catheterism, he should have recourse to relaxatives or local blood-letting, as the case may be. With *spasmodic* stricture, the patient should be placed in a warm hip-bath, and opium given by the mouth, or in the form of enema or suppository, or chloroform administered; the latter agent being of great value in overcoming both voluntary and involuntary muscular resistance. With an *inflammatory* or congestive state of the urethral passage, as evinced by a turgid penis and tender perineum, local blood-letting from the latter region by cupping, or a dozen leeches, will often effectually subdue this occasion of resistance. After either kind of auxiliary treatment, the introduction of a catheter can generally be accomplished. Recourse to auxiliary measures may be deemed advisable *before* attempting to pass an instrument, and certainly this would be better than any risk of injuring the urethra by rough manipulation.

Forcible catheterism, or forcing the stricture, as it is termed, will rarely be justifiable, and never in the sense of thrusting a catheter anyhow into the bladder. The forcible dilatation or rupture of an old indurated stricture, as by Holt's operation, offers an occasional resource for the relief of retention.

External Urethrotomy.—Incision of the Urethra through, or behind, the Stricture.—The first-named point of incision—through the stricture—is, in fact, perineal section; and the second—behind—may be performed in a precisely similar manner. The one has the advantage of relieving the stricture as well as the retention; the other leaves the stricture untouched, and it is performed without a guide in the urethra, by carefully deepened incisions so as to hit the passage; the finger having been introduced into the rectum to indicate the point in front of the prostate—the membranous urethra. This procedure was recommended by Guthrie and Liston, and is preferred by Mr. Spence, though it has now generally given place to puncture of the bladder per rectum. Both these urethral modes of entering the bladder have the advantage of not directly opening the bladder; and, in relieving retention, they also release any extravasated urine or matter which may have formed in the perineum.

Puncture of the Bladder through the Rectum.—Having emptied the bowel by an enema, the patient is brought to the edge of the bed, and his legs held apart as for lithotomy. The Surgeon then introduces the left forefinger, oiled, into the rectum, and feels for the posterior margin of the prostate; just beyond which point, bulging fluctuation should be perceptible, especially on tapping the hypogastric region with the other hand. The long curved trocar and cannula is then passed along the concavity of the finger, as a guide, to the same point in the middle line, and pushed upwards into the bladder, transfixing the rectum and base of the bladder in the *trigone* of the latter organ, where it is uncovered by peritoneum. (Fig. 926.) This space is free from adjoining parts; the prostate in front, the reflection of the peritoneum behind, and the vesiculæ seminales are on either side. The trocar is now withdrawn, the bladder emptied, and the cannula retained by means of a waist-bandage and tapes. In performing this simple operation, two additional practical points are worthy of notice: in passing the instrument along the finger, let the point of the trocar be withdrawn into the cannula, to avoid wounding the bowel; and leave the cannula in, but only just within the bladder, to prevent any irritation of the mucous membrane by the edged end of this tube. It is

FIG. 926.



allowed to remain for a few days, until urine flows by the natural channel, or until stricture of the urethra or other obstruction has been overcome.

The value of puncture by the rectum has been variously estimated. Mr. Cock, who has performed this operation in a large number of cases, is led to very favourable conclusions respecting it: that it is more easy of performance, and less dangerous in its results, than any mode of entering the bladder for the relief of retention. The objections made to the operation are not so much the liability of perforating the peritoneum or seminal vesicles, both of which parts may, with care in performing the operation, be avoided; but the liability to urinary infiltration, pelvic inflammation and abscess between the rectum and bladder, and a persistent fistulous opening. In one singular case that Mr. Erichsen relates, rectal flatus became diffused through the cellular tissue of the pelvis and down the thighs and nates; an emphysematous condition from which the patient died.

Puncture through the rectum should be resorted to only when, with retention from stricture, there is no sign of abscess or extravasation in the perineum; the urethra is apparently not dilated behind the stricture, nor the prostate much enlarged (Figs. 927, 928); and a catheter cannot be passed, under chloroform, with care and patience. As a rare complication, an abscess may have formed between the bladder and the rectum; or a cyst in this situation has been known to cause symptoms of retention, unrelieved by puncture per rectum, the trocar having entered only the cavity of the cyst. (Fig. 929.) These circumstances will considerably restrict the cases for having recourse to this operation.

Fig. 927.*

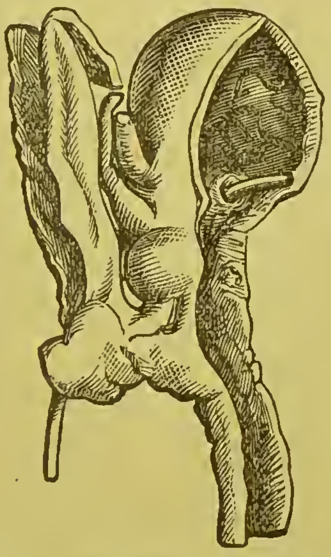
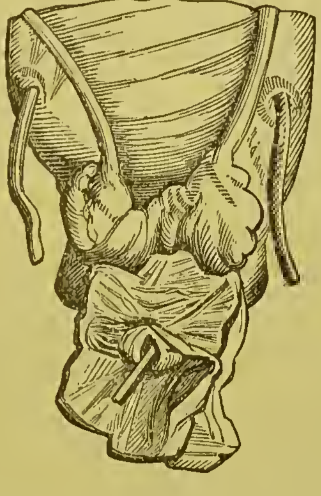


Fig. 928.†



Puncture of the Bladder above the Pubes is easily performed. A vertical incision in the middle line, and just above the symphysis pubis, is made to the extent of about two inches, and carried down through the linea alba, so as just to admit the tip of the finger to reach the distended bladder—below the peritoneal fold, which will have receded owing to the state of distension. An assistant steadies this organ by even pressure with his hands against the abdominal wall, on either side; and a slightly curved trocar is entered downwards into the bladder (Fig. 930), the urine drawn off, and the cannula allowed to remain for a few days, as may be necessary. It is secured by tapes and a waist-bandage.

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* Roy. Coll. Surg. Mus., 2014A. Puncture of bladder per rectum.

† Ibid., 2045A. Greatly enlarged prostate, with puncture per rectum; the trocar had penetrated in front of the enlarged gland, and thus the bladder was not entered, but the prostatic urethra. (E. Cock.)

FIG. 929.*

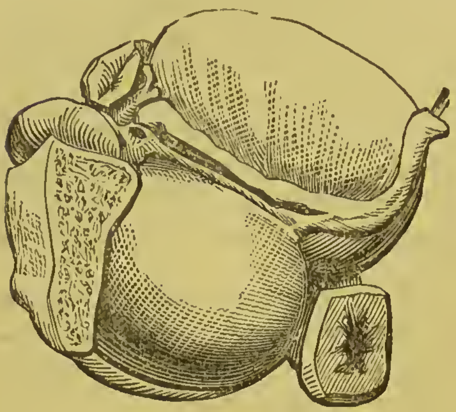
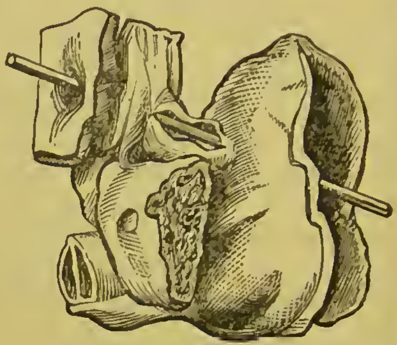


FIG. 930.†



This operation has been sometimes practised, and is strongly advocated by Mr. Paget, of Leicester, and by some other Surgeons of eminence. It is not, however, generally adopted. The objections are—some risk of urinary infiltration, or of a fistulous opening remaining. But there may be no alternative between supra-pubic puncture and rectal puncture; or the perineal section,—when, with impassable stricture, the prostate is considerably enlarged. Rectal puncture may then be absolutely impracticable, from the impossibility of reaching with the finger behind the enlarged prostate.

Puncture of the Bladder through the Symphysis Pubis.—An ordinary hydrocele trocar of medium size is introduced, with or without a small

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[*] London Hosp. Mus., A. *e.* 75. A large cyst situated between the bladder and rectum, in a boy aged two years. The cyst was as large as an adult fist; its inner surface bore several large, soft, nodular projections, and the cavity contained a bloody fluid. The whole seems to have been a cancer cyst, of the medullary character; and the nodular substance showed under the microscope nucleated cells of irregular forms. The patient had symptoms of retention of urine; and on rectal examination with the finger, a fluid tumour, like the bladder, was found occupying the bottom of the sacrum, and pushing the bladder upwards. The cyst was punctured, but only blood was withdrawn; and then the urine was drawn off from the bladder by a catheter.

[†] Roy. Coll. Surg. Mus., 2043. Supra-pubic puncture of the bladder, for retention of urine. four years before death. The track of the passage from the linea alba to the anterior wall of the bladder is partly laid open. Great enlargement of the prostate, the middle lobe projecting over the vesical orifice of the urethra. The patient, seventy years old, had symptoms of enlarged prostate for sixteen months before the operation; a cannula was retained in the bladder for nearly six months, and thus he resumed his business. Then a catheter was passed through the urethra into the bladder, with some difficulty in overcoming the enlarged prostate, and the cannula was withdrawn. Owing to atony of the bladder, the catheter had to be introduced twice daily. Symptoms of stone in the bladder set in, with renal pain; the supra-pubic aperture reopened and discharged purulent urine, and death ensued from exhaustion. One large stone and several small ones were found in the bladder and the ureters and pelves of the kidneys were full of pus. (Langstaff.)

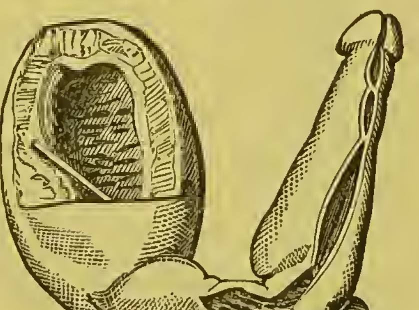
preliminary incision, about the centre of the symphysis from above downwards, and in a direction at about right angles to the vertical axis of the body. It is thrust onwards, somewhat obliquely downwards and backwards towards the sacrum, this direction being varied according to circumstances; a flexible catheter is then passed through the cannula and retained by a tape. Dr. J. M. Brander, of Jersey, in 1825, first proposed this operation; and several successful cases have since occurred in his practice, and in the hands of other Surgeons.

In the *Female*, retention of urine may arise from certain *special* causes of mechanical obstruction:—as from the accumulation of menstrual fluid owing to imperforate hymen; during pregnancy or parturition, from compression of the gravid uterus or the head of the child upon the urethral canal; and uterine tumours or displacements of the uterus may act in like manner. Hysterical retention, of functional and paroxysmal character, is perhaps peculiar to the female sex.

Treatment consists in the removal of any cause of retention. Thus, in hysteria, remedial measures must be directed to the constitutional condition; and when retention results from some obstruction to the passage of urine, the particular cause must be discovered, and overcome if possible. The introduction of a catheter may be necessary to afford relief, a procedure with which, in regard to the retention of urine in a female patient, the young Surgeon should be familiar, that he may perform it expertly and with delicacy.

EXTRAVASATION OF URINE.—This may result from unrelieved retention of urine, in stricture; and generally the urethra is ruptured behind the seat of obstruction, the bladder very rarely. But the urethra is also liable to be ruptured by the obstruction arising from an impacted calculus; or by a false passage, from unskilful catheterism; by a fall across a beam, or kick on the perineum; or by fracture of the pelvis, implicating the urethra. In either way, extravasation of urine takes place.

FIG. 931.*



Rupture of the Urethra occurring behind the seat of stricture, the point of rupture is almost invariably the membranous portion of the urethra and just in front of the triangular ligament. Here, the urethra is naturally weak, and has become dilated in the form of a sacculus or pouch, by the constant distending pressure of the urine, resisted by the strictured passage in front. (Fig. 931.) Under this pressure, the weak and dilated urethra tends to yield; but the immediate cause of extravasation seems to be ulceration of the mucous membrane, either from urinary irritation, or as the result of an abscess forming close to this part of the urethra, externally, and which induces ulceration into the canal. The urine escaping from the urethra, or becoming extravasated into the adjoining cellular tissue, gradually infiltrates this texture beneath the deep layer of the superficial fascia in the perineum; and the fluid following the boundaries of this fascia, it forms a bag, limited by the base of the triangular ligament below, and the rami of the pubes laterally; thence continuing upwards, the scrotum and penis become infiltrated, then the lower part of the abdomen, and outwards to the line of Poupart's ligament on either side; but there is no extension downwards on the thighs.

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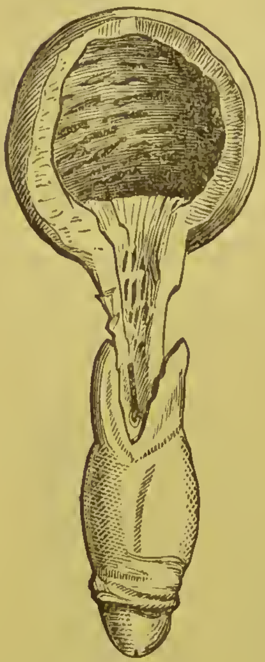
* St. Thomas's Hosp. Mus., DD. 32. Stricture of the spongy portion of the urethra, in the form of two tight annular contractions, and old puckered cicatrices and membranous bands, transverse and longitudinal, in the membranous and prostatic portion of the canal: with dilatation of the urethra behind the annular strictures, great thickening of the bladder from hypertrophy of the muscular coat, and rugous state of the mucous membrane. A piece of whalebone, introduced through a perineal incision, indicates the course of a false passage along the side of the prostate gland, and which penetrates the cavity of the bladder.

The *symptoms* of extravasation are remarkable:—the characteristically bounded swelling, and its increasing size and extent; the scrotum and penis especially becoming enormously distended,—the one perhaps to the size of a large cocoa-nut, the other to that of a Bologna sausage; a sensation of sudden relief of the distended bladder is immediately followed by an acute burning sensation in the perineum; gangrenous inflammation of the cellular texture soon supervenes, the skin assumes a dusky-red hue, purplish or black gangrenous spots appear, and frequently one such patch is seen on the dorsum of the penis. Ultimately, sloughing of the skin and cellular texture of the scrotum exposes the testicles, bare and pendulous. Sometimes the urethra bursts just in front of the bulb; when, in addition to the swelling of ordinary extravasation, the urine infiltrates also the corpus spongiosum of the penis, which is soon followed by gangrene of the glans, in the form of black spots or having a generally black appearance; thus indicating this further urinary extravasation. (Fig. 932.) The constitutional disturbance is that of low typhoidal depression; a rapid feeble pulse, dry brown or black tongue, and muttering delirium as death approaches.

FIG. 932.*



The *diagnosis* might be misled by the resemblance of the swelling to that of phlegmonous erysipelas; but the above characters, taken in connection with the retention of urine, will indicate the nature of the attack.

Treatment.—The primary indication of treatment is to give an immediate, free, and dependent outlet to the extravasated urine, with the fœtid purulent fluid and sloughs of cellular texture which soon form. This indication is, therefore, both preventive and remedial. Hence an incision or two should be made in the scrotum on either side of the middle line; exposing the cellular texture, and extending from the front to the back of the bag. Another incision may be made on the dorsum of the penis, and perhaps another over the pubes. A quantity of strong-smelling or ammoniacal urine trickles out, and continues to ooze for hours or days; at the same time, the peculiar appearance of the cellular texture—its pearly white colour and tension, or its opaque, sodden, and matted appearance—indicates the urinary infiltration, or the supervention of sloughing. Tension having been thus relieved, a catheter can often be passed through the stricture into the bladder. This should be done at once, and the instrument retained in the usual manner by means of a waist-band and tapes. The catheter is left *unplugged*, that the urine may drain away from the bladder, and as the instrument occupies the *calibre* of the urethral canal, both these provisions will prevent any further extravasation. By this arrangement also, the ruptured urethra heals over the instrument. A large poultice or warm fomentation, or an antiseptic application, is placed around the scrotum and over the whole extent of the extravasation. The relief afforded by the incisions is almost instantaneous, the patient often soon rallying from the previous state of nervous prostration and low fever. Stimulants, in the form of wine or brandy, with supporting nutriment, may now be given advantageously; and bark, with chlorate of potash or ammonia, will prove very beneficial. Opium also is a most valuable agent; in the early period, to counteract the nervous excitement which not unfrequently accompanies prostration, and afterwards, when excitement sometimes prevails, to subdue it.

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* Roy. Coll. Surg. Mus., 2548. Gangrene of the body of the penis, from extravasation of urine into the corpus spongiosum; owing to ulceration of the floor of the urethra, about three inches from the external meatus. (Hunterian.)

The subsequent treatment of sloughing and granulation, after a long and trying process of exhaustion and repair, must be conducted on ordinary principles.

Rupture of the Bladder—a very rare consequence of retention—is attended with extravasation of urine into the peritoneal cavity; or more commonly, below the line of the peritoneal reflection, into the pelvic cellular texture, whence it may secondarily get into the peritoneum by ulceration.

The symptoms are sudden and acute abdominal pain, the patient usually feeling that something has given way; and there is overwhelming collapse. Dulness on percussion over the region of the bladder is now substituted by general abdominal fluctuation and distension, with total inability to strain out a drop of urine. The most acute peritonitis sets in. Maniacal delirium sometimes appears to supersede the collapse, but death is inevitable in a period varying from thirty-six hours to four or five days.

The indication of *treatment* would seem to be that an outlet should be given to the urine by puncture of the abdomen. But no such cases are recorded; and any treatment has hitherto had no effect in averting the inevitably fatal issue.

Suppression of Urine differs entirely from retention, there being no urine secreted.

The symptoms are those of uræmic blood-poisoning, owing to the retention of urea, and the other urinary constituents, in the blood. Commencing sometimes with a rigor, an aching pain in the lumbar region is accompanied with a sense of exhaustion, succeeded by vomiting and feverishness of a typhoidal character, with urinous-smelling perspiration; delirium, convulsions, and coma supervene, and the patient dies in the course of three or four days, or perhaps a week. The suppression is sometimes transient; urine is resecreted, and the perilous symptoms pass off. No difficulty can be experienced in distinguishing any such attack from that of retention of urine. With suppression, in addition to the other symptoms, no urine is passed, or only a few drops, and the introduction of a catheter fails to obtain any; nor is there supra-pubic dulness on percussion, the bladder being empty.

This arrest of the urinary secretion may be referable to various causes—a symptom of many diseases. Commonly arising from disease of the kidneys, as congestion, or of a structural character, as in Bright's disease, suppression of urine not unfrequently proceeds from some powerful impression on the nervous system, as the shock of injury or surgical operation. But it may also occur in the course of fevers, or other blood-poisoning. According to this diversity of causation—by renal or systemic disease—the suppression may be gradual and incomplete, yet fatal; or an attack, sudden and complete, but perhaps of temporary duration.

Treatment can do very little to restore the secretion of urine. But the effort should be promptly made, by cupping the loins, or dry-cupping; with sudorific medicines, the warm bath or hot-air bath, in order to promote sweating, and purgative enemata, thus also to aid the elimination of excrementitious matters. Whether stimulant diuretics should be administered to force the kidneys to renew their function, is a very questionable practice, both in regard to its efficacy and safety. For this purpose, however, cantharides has been given in grain doses, coupled with the application of a large blister to the loins; and this method of treatment is said to have proved successful in some instances.

FIG. 933.*

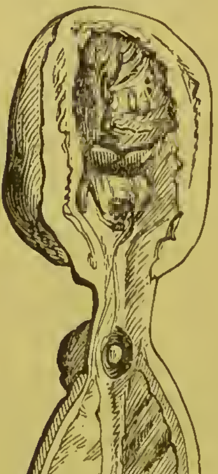
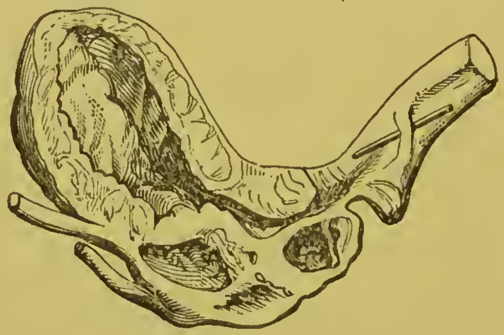


FIG. 934.†



URINARY ABSCESS.—Suppuration circumscribed by plastic matter, forming an abscess, is liable to occur close to the urethra in some part of its extent. It may arise from any source of urethral irritation; usually the collection of urine in the dilatation behind a stricture, or from urethritis, or simply from irritation of the passage of instruments. The suppuration is apparently induced either by ulceration of the mucous membrane, allowing of slight urinary extravasation into the sub-urethral cellular texture (Fig. 933), and which thus becomes a direct source of irritation; or, abscess may perhaps result from the influence merely of the irritation in the adjoining portion of the urethral canal. (Fig. 934.) In the one condition, abscess, proceeding from the canal, may open externally; in the other condition, abscess, forming outside the canal, may open into it, and externally. Urinary abscess is liable to form in various situations, in relation to the urethral tract; and it is thence designated *perineal*, *scrotal*, *intra-pelvic*, and *ante-scrotal* or *penile*. This also represents the order of frequency in the situations of such abscess.

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* Roy. Coll. Surg. Mus., 2551. Stricture of the urethra, with small abscess in the bulb, *communicating*. Bladder thickened. (Liston.)

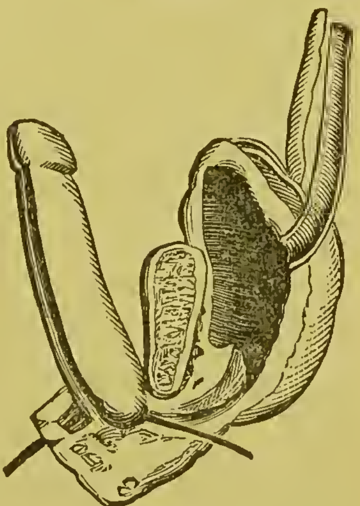
† Ibid., 2549. A short but very narrow stricture of the urethra, half an inch anterior to the bulb; abscesses within, and adjacent to, the prostate gland, which communicate with each other; yet none of these abscesses open into the *urethra*, nor externally. Bladder thickened. (Langstaff)

A small, circumscribed, hard, and painful tumour is felt, in the neighbourhood of the urethra, which scarcely attains any considerable size, unless in the perineum. It is not attended by much constitutional disturbance.

Treatment.—Early incision is absolutely necessary, to prevent further extravasation of urine, or the formation of urinary fistula. A free, and often deep incision, in the middle line, will give instant relief to tension or afford exit to matter. The part should then be well poulticed.

URINARY FISTULÆ commonly result from urinary abscess, communicating with the urethra, and externally. The internal opening is generally in the membranous urethra, just behind the usual seat of stricture; the external opening is most frequently perineal (Fig. 935) or scrotal; and the intervening parts are traversed by the fistulous passage, or passages in various and often devious routes. Sometimes the fistula is ante-scrotal or penile; and here the communication with the internal or urethral opening is almost direct. Less frequently, the openings of urinary fistulæ are found in the groins, the upper part of the thighs, the adjacent part of the nates, or even above the pubic symphysis. In size, the fistulous passages differ considerably; some admitting only the finest probe, others readily the finger. In point of number also, they vary remarkably; penile fistulæ being usually single, whereas scrotal and especially perineal fistulæ are often numerous. Fifty-two openings Civiale found in one such case. The surrounding structures differ so much in their condition as almost to warrant the distinction of urinary fistulæ into two classes: the *simple* or healthy fistula, and the *indurated* fistula. In the latter condition, the fistulæ are sometimes connected with cavities secreting pus, and detaining in their interior some quantity of the urinary secretion. The surrounding parts share the induration; the scrotum and penis becoming enormously enlarged and brawny, or almost cartilaginous. Another and more important distinction which characterizes a class of urinary fistulæ, is that wherein the urethral opening results from actual *destruction* and *loss of substance*, by sloughing, in consequence of urinary extravasation, phagedænic ulceration, or mechanical injury. A portion of the floor of the urethra

FIG. 935.*



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* St. Mary's Hosp. Mus., H. *h*. 9. Perineal abscess, communicating with the urethra, just in front of the membranous portion, and having a fistulous opening externally. (Samuel Lane.)

having been destroyed, and the tissues intervening between it and the external surface, the urethral mucous membrane of the upper aspect or roof of the canal becomes visible from the outer orifice of the fistula. Such apertures may be found in similar situations to those of abscess-fistulæ; as perineal, scrotal, and ante-scrotal or penile fistulæ.

The symptoms of urinary fistula, having reference to the act of micturition, are characteristic of the existence of such fistula; and are tolerably distinctive as to its situation, size, and mode of origin.

In all urinary fistulæ the urine escapes, partly at least, by the fistulous opening or openings; in the latter condition, the urine spurting out perhaps as if it were issuing from the rose of a water-pot. This may be often seen in perineal and scrotal fistulæ, where numerous openings frequently coexist. The situation of the internal opening is less correctly indicated, owing to the devious routes of the fistulous passages. But the seat of stricture will supply this information. According to the size of the fistulous communication, more or less urine will escape through the unnatural passages; and proportionately, less or more by the urethra. And the mode of micturition in this respect is tolerably diagnostic of fistula which results from destruction of a portion of the urethral canal; the whole or nearly the whole of the urine then passing by the artificial channel in a full stream.

Treatment.—When a stricture, followed by abscess, is the cause of the fistula, the primary indication of treatment will be the removal of that condition. This may be done in the usual manner; by dilatation, internal urethrotomy occasionally, external urethrotomy more commonly,—and usually the perineal section, owing to the situation of the stricture. Having thus succeeded in enabling the urine to flow by the natural channel, the fistulous passages are set at rest, and they not unfrequently contract and close. Thus, both *simple* and even indurated urinary fistulæ may be cured.

But *old*, *indurated* fistulæ are indisposed to heal, although the original cause has been thus removed. Recourse must be had to additional treatment for this purpose. The measures remedial in chronic fistulæ generally are here also applicable, and may have to be tried in succession. They are, chiefly—stimulating applications to the fistulous tract; compression; and incision along the course of the fistula to induce healing from the bottom. Of *stimulating applications*, various agents have been employed; in the form of injection by means of a fine syringe, as tincture of cantharides, solutions of nitrate of silver, sulphate of copper or of zinc. A probe coated with fused nitrate of silver may be passed along the tract occasionally, and this will often succeed in causing contraction. The actual cautery is sometimes curative, applied in the form of a red-hot wire, or the galvanic-wire cautery, which can be conveniently introduced along the tract before being heated by the current. *Compression*, by means of an india-rubber air-pad, applied to the perineum, has proved successful in some cases of perineal fistulæ. *Division* of the fistulæ along their course nearly to their origin in the urethra, can be accomplished as usual, with a grooved director and narrow, blunt-pointed bistoury. Several passages may be thus thrown into one, and strips of lint should then be inserted to provoke granulation from the bottom of the tract.

During recourse to these measures for the cure of urinary fistulæ any passage of urine along their course must be prevented, by regularly using the catheter three or four times a day. The patient may be instructed how to do this for himself, at every call of nature.

Respecting the eligibility of these modes of treatment; in long, narrow, and tortuous fistulæ, stimulation and compression seem to be the most appropriate; when the fistulæ are large and numerous, incision is more suitable, the perineum and scrotum being sometimes quite riddled in all directions.

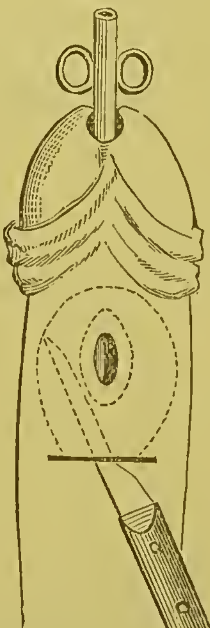
Larger-sized urethral openings, in consequence of actual *destruction* of some portion of the wall of the canal, require operative interference of a plastic character, to repair the loss of substance.

Urethro-plastic operations are designed to effect reparation in one of two ways: either by simple closure of the fistulous aperture, or by borrowing the surrounding integument to accomplish this object. These procedures are severally applicable according to the part of the canal where the opening exists.

Perineal fistula may admit of closure by simply paring the edges down to the urethra, and uniting them with quilled sutures, or by Bozeman's buttons.

Ante-scrotal or penile fistula is much more difficult to close, owing to the want of substance in the coverings of the urethra at this part of its extent, and the liability of the part to disturbance by erection of the organ or other motion. . When the opening is *small*, Dieffenbach's mode of closing it may be adopted. It consists in first stimulating the edges, by frequently touching the surrounding skin with the strong tincture of cantharides the day before the operation, and then using the "lace suture." A sound is introduced into the urethra beyond the opening; the operator takes a small curved needle, sharp at the point but not at its sides, armed with a stout waxed silk thread, and by means of a needle-holder introduces it beneath the skin at about three lines from the border of the fistula. The needle is carried deeply, but not into the urethra, and made to emerge at another point; then dipped again, and so on by three or four stitches, carried round the opening, until it emerges at the point of entrance. The thread, thus imbedded in the cellular texture around the fistula, is drawn by its two ends together, so as to close the opening, and then fastened by a knot. In three or four days the ligature may be divided, and drawn away. A *larger-sized* aperture will probably require some substitution of the surrounding skin, and this may be accomplished by Nélaton's operation, as follows:—The edges of the fistula having been pared, the skin around to the extent of about one inch must be dissected by passing a small narrow-bladed knife subcutaneously around the aperture (Fig. 936); thus forming a detached area of integument, which is brought together over the opening, and the edges united by a few points of fine suture. This procedure may sometimes be advantageously modified by making lateral incisions, and then passing across underneath the flap a slip of india-rubber, to prevent contact of the

FIG. 936.



urine, which would disturb the process of adhesion in the line of closure over the urethral opening.

During the course of reparation by any of these urethro-plastic operations, the urine must always be drawn off gently by a catheter, three or four times daily.

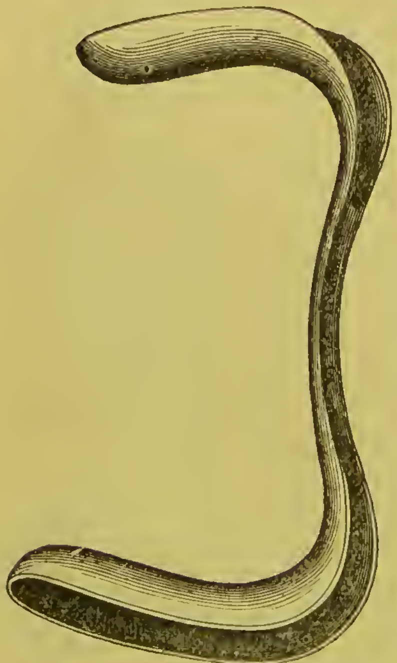
Urinary-Vaginal and Uterine Fistulæ.—Fistulous openings may be established: (1) between the urethra and vagina; (2) between the bladder and vagina; or (3) between the bladder and uterus. These communications result from contusions or laceration in parturition, the introduction of foreign bodies, the effects of calculous concretions in the bladder, or operations for their removal. Openings caused by the extension of cancerous ulceration are here omitted, as such fistulæ are quite incurable.

Much and persevering attention has been given of late years to the surgical treatment of the various forms of simple fistulæ; and results have been obtained, in a large number of cases, sufficient to establish the operative cure of these distressing conditions as a finished achievement. We are chiefly indebted, for this addition to Surgery, to the labours of Dieffenbach, Dr. Bozeman, Mr. Baker Brown, Dr. Marion Sims, Professor Simpson, Mr. Bryant, and Mr. Spencer Wells.

The principal features connected with the operations as more recently practised, and which have led to their increasing success, are thus enumerated by Mr. Jonathan Hutchinson. Speaking chiefly of vesical fistulæ; 1st, the use of chloroform, which facilitates the difficult step of the dissection; 2nd, the use of metal sutures instead of silk; 3rd, the avoidance of the vesical mucous membrane, both in the dissection and in the application of the sutures; and 4th, increased attention to keeping the bladder empty afterwards. It may be added that metallic or wire shields, adjusted over the line of union, were much relied on a few years since; but they are now generally discarded in favour of sutures alone.

Vesico-vaginal fistula may be taken as the type of the three urinary fistulæ, relating to the vagina and uterus. The requisite operation consists in completely paring the edges of the vaginal aspect of the fistula, and then uniting them by suture. But many particulars should be observed, as tending materially to the success of this procedure; and they are tersely stated in the following summary by Hutchinson, which I can indorse by my own experience:—The instruments used are small tenotomy-like knives, forceps, needles, and fine silver wire. Instruments for carrying the wire have also been devised, as Startin's tubular needle. The patient should be in her best state of health, and the bowels have been well cleared out. Chloroform having been given,

Fig. 937.



* Sims's duck-bill speculum.

the woman is placed either on her side, with the knees well drawn up, or in the usual lithotomy position. The parts being thoroughly exposed by a duck-bill speculum (Fig. 937), and the nates being held widely apart by an assistant, the operator proceeds to drag the opening as low down as possible, with a view to facilitate the paring of the edges. This may be accomplished either by hooks, blunt or sharp; by means of a metal suture; or by the introduction of a flexible sound through the urethra, which is brought out again through the fistula, and then bent backwards. This latter plan furnishes the Surgeon with a most efficient hook, and one which cannot easily slip. In paring the edges, it is necessary thoroughly to denude every part; for if the smallest portion of mucous membrane be left, it may prevent union. None of the mucous membrane of the bladder must be removed. The wound should present a bevelled oblique line, slanting from a large vaginal opening to a smaller vesical one. The denudation being complete and free, sutures are next to be introduced. These should be passed obliquely from at least a third of an inch outside the edge of the incision. They must not include the mucous membrane of the bladder. The tightening and tying of wire sutures is easily accomplished by the fingers. Care must be taken not to pull them too tight, so as to invert the edge of the vaginal mucous membrane.

After-treatment is simple. The small, double-curved silver catheter, invented by Dr. Sims, or an ordinary gum-elastic one, should be passed and retained unplugged, that the urine may continuously drain out of the bladder. This should be constantly watched; and the instrument cleansed and then re-introduced twice a day. The patient must lie on her side, with the knees drawn up, and her general health be well sustained. It is of the utmost consequence to prevent the action of the bowels for at least a week; and this may be accomplished by administering a full dose of opium soon after the operation, and maintaining its influence subsequently by smaller doses. Dr. Sims lays much stress on this point as an element of success. The removal of the sutures prematurely is a greater evil than their unnecessary continuance; they should certainly not be withdrawn before the ninth or tenth day, and then with great caution.

Urethro-vaginal fistula is more easily closed by a similar procedure; but union takes place less readily, owing to the unavoidable pressure of the catheter on the line of union. This I have experienced in my own operations. It is better therefore to adopt the practice now, I believe, generally pursued; that of withdrawing the urine occasionally, by gently passing a catheter, or even to allow micturition, from time to time, without interference. Scrupulous cleanliness should of course be observed.

Vesico-uterine fistula is that condition wherein the fistulous communication exists between the bladder and cervix uteri. Certain modifications in the plan of operation will be required. It might become desirable to obliterate the upper part of the vagina, in order to connect the uterus with the bladder; thus allowing the menstrual fluid to pass through this organ, but preventing incontinence of urine.

These operative procedures may have to be repeated a second or third time, and even several times, in the same case; partial closure only being effected in the first instance, and afterwards more and more completely. Such temporary failure, however, will not weary the perseverance of the true Surgeon, nor the endurance of the patient, who is too glad to get rid, even by degrees, of a most troublesome, offensive, and socially distressing urinary leakage. But it not unfrequently happens that a pin-hole opening only remains, defying any plastic procedure. In common with other Surgeons, I have had to contend with this difficult residue of the operation. No means of closing the aperture will, I believe, prove effectual, except the introduction of a red-hot wire, or better, the galvanic-wire cautery.

CHAPTER LXV.

INJURIES AND DISEASES OF THE PENIS.

THIS organ is liable to Injuries and Diseases in common with other parts of the body, presenting, however, special features of importance; and to certain Malformations or Congenital Defects which are necessarily peculiar to it.

INJURIES.—*Wounds*, and *Laceration*, of the Penis have two important characters: copious hæmorrhage, and possibly, implication of the urethra. These lesions may be produced by instruments, whether sharp-cutting, penetrating, or lacerating; or by external violence, as gunshot injury; and they may be accidental, or sometimes vindictively inflicted, or even self-inflicted. But the tendency to reparation is remarkable, especially in the integumental portion of the organ.

Hæmorrhage.—The erectile structure of the penis is not unfrequently the source of hæmorrhage; the blood issuing either from the corpora cavernosa, the corpus spongiosum, or from both; and in the form of a free, persistent dripping or oozing. The dorsal artery or the artery of the corpus cavernosum may, however, be the source; the blood issuing in the usual manner, as a jetting arterial stream. In extensive wounds of the penis, the blood proceeds both from the erectile structures and from the arterial trunks.

The *treatment* will vary accordingly. Oozing hæmorrhage may be arrested by cold or astringent applications, and pressure. A large catheter should be passed into the bladder, as a means of counter-support, and compression effected by a finger-bandage or circular strips of adhesive plaster. Compression with a pad of lint, thus retained, is sometimes sufficient, without the resistance afforded by a catheter. Arterial hæmorrhage must be managed by ligature; or perhaps torsion, when the vessel is free and can be well twisted with the forceps.

Rupture of the Frænum I have known to be caused by injury in sexual intercourse; the artery of the frænum, being torn, may bleed profusely, even until faintness is induced. If the artery be partly torn across, its complete division, by a snip with scissors, will at once arrest the hæmorrhage; or, if the mouth of the vessel fail to contract, a pledget of lint may be inserted in the angle of the wound, and the prepuce drawn forwards over it.

Wound of the Urethra.—This lesion may occur as part of a penile wound, or independently,—the urethra alone being cut or penetrated. And the wound may be partial or complete division of the urethra.

The *signs* are—the escape of blood from the meatus, or in micturition,—bloody urine; and escape of urine from the urethral wound. In the ante-scrotal portion of the penis, the wound is easily discovered on examination.

Treatment consists in at once passing a gum-elastic catheter through the external meatus into the bladder, and retaining the instrument; the edges of the wound can then be brought together over the instrument, by fine strips of plaster or a point or two of suture.

Laceration of the urethra is specially apt to happen in connection with fracture of the pubic rami, or from external violence, as a kick in the perineum, or a fall astride a girder or the edge of a plank of wood. The membranous urethra is here the seat of injury; and the laceration may be partial or complete, the urethra being torn partly or entirely across. There is also more or less perineal ecchymosis or bruising.

Certain *signs* are distinctive of laceration. Urethral hæmorrhage or bloody urine appear as from wound; but the effort of micturition is accompanied with a deep burning pain, and symptoms of urinary extravasation, commencing in the perineum, rapidly supervene. If laceration be complete, there is inability to pass urine, and extravasation proceeds with greater rapidity. This condition may terminate in urinary fistula.

Treatment is essentially the same as in wound of the urethra. A catheter should be at once passed, to allow of urethral reparation, and, in the case of laceration, to prevent the extravasation of urine which cannot here escape by an external wound. With *complete* laceration of the urethra, it may be very difficult or impossible to pass a catheter. Having, therefore, introduced the instrument as far as it will go, a free incision should be made in the middle line upon the point of the catheter, which can then probably be passed onwards into the bladder. Or, at least, an outlet is thus provided for the urine. If, with this precaution, retention ensues, puncture of the bladder through the rectum may be justifiably resorted to.

Extravasation of urine, or perhaps *urinary fistula*, as the result of urethral laceration, must be treated as already explained with reference to these conditions.

Diseases.—Balanitis.—Inflammation of the thin mucous membrane of the prepuce and glans penis is attended with some redness and smarting, and a profuse, thin, opalescent, muco-purulent discharge, with some infiltration of the prepuce bordering on phimosis. Excoriation is apt to occur. When the mucous membrane of the glans is specially affected, the inflammation is known as *Posthitis*. The prepuce is not unfrequently long and redundant, a condition which seems to predispose to Balanitis.

This inflammatory affection is usually the result of local irritation; from gonorrhœal discharge frequently, and hence named "external" gonorrhœa, or simply from want of cleanliness; but it also arises in young and delicate boys, from disordered health, and during hot weather.

The *treatment* is chiefly topical; a slightly astringent wash, as lead lotion or lime water, or slight pencilling with nitrate of silver, especially in the groove around the corona glandis. Saline, cooling medicine may also sometimes be given with advantage.

Chronic Balanitis—unattended with much redness and smarting—often induces a fleshy, rough, or granular thickening of the preputial mucous membrane, and the discharge is still abundant. In this state, the membrane may be dusted with a mixed powder of calomel and calcined magnesia. When conjoined with phimosis, astringent injections must be used beneath the prepuce, which cannot then be uncovered. Or ointments may be applied with a camel's-hair brush. The following Mr. Langston Parker finds to be very efficacious: "hydrargyri chloridum mitis," ʒss.; extract of opium, ʒi.; simple cerate or honey, and olive oil, of each ℥i.

A persistent tendency to balanitis, induced by a long prepuce, can perhaps be overcome, according to the suggestion of Professor Bumstead, by keeping the prepuce constantly retracted; this being accomplished by the application of a narrow bandage (or strip of plaster?) around the penis, behind the glans. In the course of a few weeks, the exposed mucous surface becomes hardened, and the foreskin often remains retracted. Failing this result, the superfluous integument should be removed by circumcision.

Phimosis.—By this term is meant a contracted state of the orifice of the prepuce or foreskin, whereby the glans cannot be uncovered completely, if at all; the orifice being reduced to even a pin-hole opening. This condition of the prepuce may be congenital, or acquired; and these two modes of origin sometimes coexist.

Congenital phimosis, a not uncommon defect, is associated usually with an elongated and redundant state of the preputial skin, so as to project beyond the glans; but the mucous membrane is deficient, and thus prevents retraction. Adhesions sometimes exist between the opposed surfaces of this undeveloped membrane and the glans; and the glans itself is small, owing apparently to the restriction offered by the prepuce to its development.

A source of inconvenience only at first, phimosis gives rise eventually to symptoms of vesical irritability, incontinence, and even to retention of urine; or often to symptoms simulating stone in the bladder. By the accumulation of sebaceous preputial secretion, irritation and inflammation of the part, or balanitis, is apt to arise; and in after-life, sexual intercourse is rendered abortive by the contracted prepuce retaining the emitted semen. Impotency might then be suspected. In the event of gonorrhœal or syphilitic infection, the preputial condition more or less conceals the nature of the case, and interferes with the local treatment.

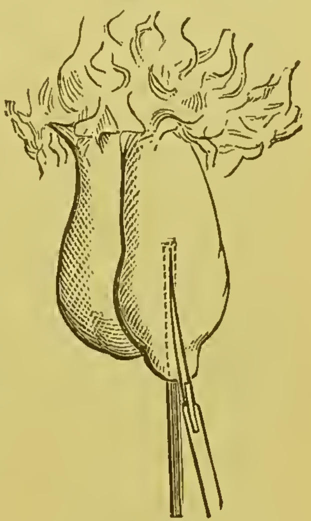
Acquired phimosis is the result of repeated balanitis and thickening of the prepuce, or of chancres with induration, or their cicatrization and contraction,—especially when seated near the orifice of the prepuce.

Treatment.—The cause and the degree of phimosis will indicate whether the remedial measures should be operative or not. In *acquired* phimosis, an acutely inflamed state of the prepuce, or an unhealthy sore, forbids operative interference, lest the wound should become unhealthy. Preputial injections may be used, and when the causative condition has been subdued, the contraction will probably gradually disappear. Otherwise recourse must be had to operation. But if the contracted prepuce conceals the nature of a sore; or if, this having a destructive character, as a phagedænic or sloughing ulcer, the requisite applications cannot be made; then an operation is at once necessary to expose the sore for its treatment, though not to relieve the contraction. In *congenital* phimosis, an operation may always be performed, for the sake of convenience and cleanliness; unless the prepuce can be retracted with tolerable facility for either purpose. This, however, is usually the tightest form of phimosis, and where the prepuce is also redundant.

The operations for phimosis are of two kinds; the contracted prepuce may be slit up, or circumcision may be performed. Both operations are sometimes requisite.

Slitting up of the Prepuce.—A grooved director is introduced between the prepuce and glans, and moved to the front so as to know that it is not in the urethra; a narrow, curved, sharp-pointed bistoury is then passed along the groove and thrust through the prepuce, dividing it as the knife is withdrawn outwards. (Fig. 938.) The mucous membrane and the skin should be severed to an equal extent, but the incision need not be usually more than half an inch in length, the contraction being at the orifice of the prepuce. Two or three points of suture will be necessary to bring the mucous membrane and skin together, in each half of the prepuce; and thus promote union by adhesion. If this be not done, the skin and membrane become separated by considerable swelling after the operation, and heal by granulation,—a slower process, and which leaves a thickened margin to either flap of the prepuce. I am accustomed to modify this simple operation to a procedure yet more simple; I divide only the mucous membrane, and retract the prepuce as the knife is withdrawn; thereby unsheathing the glans to the requisite extent for its complete release. A blunt-pointed bistoury, or a concealed knife, may be used: the latter instrument being sufficient for the operation without a director. Of course, no sutures are required.

Fig. 938.



Circumcision.—The prepuce must be drawn well forwards, until that portion which corresponds to the back of the glans is brought in front of it; the projecting prepuce is then seized immediately in front of the glans with a pair of narrow-bladed forceps, and held by an assistant; when the free portion of the prepuce—already placed on the stretch—is severed just in front of the forceps by one stroke of a bistoury. On removing the forceps, the mucous membrane will be seen embracing the glans, and this must be snipped up with a pair of blunt-pointed scissors, sufficiently to uncover the glans; and the frænum also snipped across if necessary. Any small arteries, on either side, and one or two near the frænum, must be secured by ligature or torsion; for, although bleeding slightly at the time, these vessels are apt to be the source of profuse hæmorrhage afterwards, even to the amount of three or four pints of blood. A few points of suture—five or six—should then be inserted to unite the mucous and cutaneous margins around the circular incision. If, after snipping up the mucous sheath, the flaps are found to be thickened, or the seat of warty vegetations, such membrane had better be clipped off on either side with the scissors.

In congenital phimosis sometimes, adhesions between the prepuce and glans require to be dissected up; or a quantity of white epithelial matter may have accumulated as a cake around the glans, and this must be gently scraped off.

Of the two operations—slitting, and circumcision, of the prepuce—the latter procedure is more generally applicable, as giving the cleanest result, and it is absolutely necessary when the prepuce is in a diseased state.

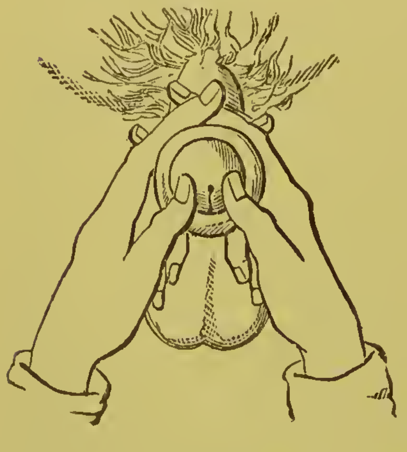
After either operation, care should be taken that the urine does not come in contact with the wound. Hence it has been suggested that the patient should micturate with his penis dipped in a bowl of tepid water. Usually, after a few days, the line of incision will have healed.

Paraphimosis.—In this—the opposite condition to phimosis—the prepuce is in a forcibly retracted state behind the corona glandis, whereby the glans cannot be covered. The constricting preputial orifice soon becomes the source of strangulation; resulting in swelling of the prepuce, which encloses and buries the seat of stricture in a deep furrow, with a roll or collar of the swollen prepuce in front and behind; congestion and swelling of the glans are superadded; and thus the reduction is rendered proportionately difficult or impossible. Most severe pain attends this state, increasing to torture; and ulceration and extensive sloughing are apt to follow.

Paraphimosis occurs most commonly in boys; or in adults, who, having naturally a narrow preputial orifice, or tendency to phimosis, happen to have allowed the prepuce to remain drawn back for a while. A diseased and indurated state of the prepuce, when retracted, will also tend to induce constriction; and paraphimosis not unfrequently arises in this way from chancre.

Treatment.—*Reduction* should be effected without delay. Any cold or astringent applications are of little avail, the source of constriction and strangulation still remaining. Chloroform may sometimes be administered, as the reduction by manipulative compression is necessarily painful, and of some duration. Then the Surgeon takes the body of the penis between his forefingers, just behind the swollen prepuce; he compresses and pushes back the glans with his thumbs, at the same time drawing the prepuce forwards, which slowly rolls over the glans as this disappears. (Fig. 939.) There will still be a tendency to retraction, so that a little continued compression of the whole end of the organ, for a minute or two, may be advisable. In ninety-nine cases out of a hundred, this method of treatment will prove successful.

Fig. 939.



When reduction cannot be effected by this procedure, after fair trial, the stricture must be *divided.* This is done by separating the two swollen folds of the prepuce to reach the circular constriction, in the furrow between them; and then dividing it with the point of a narrow bistoury on each side of the middle line, thus avoiding the dorsal vessels of the penis. A slight incision, almost a touch with the knife, will be sufficient to enable the prepuce to be drawn forward in the manner just described. It may be requisite to make a few punctures in the swollen preputial folds to evacuate serous fluid, before reduction can be accomplished. And perhaps also, the effusion having become partly consolidated, the prepuce cannot be drawn forwards; although the stricture has been divided. But, in a few days, the swelling subsides by absorption, and then reduction becomes easy. The *period* after paraphimosis when division of the stricture becomes necessary is, I should say, usually about thirty-six hours; and later than that, the swelling may have to be diminished by the additional aid of puncture, or by absorption.

Gangrene.—Inflammation and œdema of the prepuce are often met with, but gangrene seldom, unless in consequence of a chancre having assumed a sloughing character or a state of sloughing phagedæna. Sometimes, from ulceration of the urethra, gangrene has arisen from extravasation of urine into the corpus spongiosum; of which I have seen a case, and have figured a specimen in another case,—in connection with the signs of Extravasation of Urine. Gangrene of the penis has also been known to ensue in typhus fever and in paraplegia. A case of spontaneous gangrene occurred in a patient under the care of Mr. Partridge, in King's College Hospital; and I have known a gangrenous patch to form, in a patient whom I attended for orchitis which rapidly proceeded to sloughing.

Hypertrophy of the Prepuce.—As the result of chronic inflammation, a solid œdema of the prepuce may subside; but an hypertrophied condition or a kind of elephantoid growth of the prepuce is sometimes produced, necessitating excision. In one such case, which Vidal relates, the organ had attained to an enormous size; as large as a thigh and reaching to below the knees. Yet this monstrous growth was successfully excised.

Warts.—The mucous membrane of the prepuce and glans is often the seat of warty growths, as the result of long-continued irritation from gonorrhœal discharge or that of a syphilitic sore. The ichorous matter accumulating under the prepuce gives rise to these growths, especially in the furrow around the corona glandis. Cleanliness is, therefore, the best preventive.

Treatment is removal of the growths; either by snipping them off with curved scissors, or destroying them by dusting the surface with a powder consisting of equal parts of savine and copper.

Cancer of the Penis occurs in two forms: Scirrhus, and Epithelial cancer. The characters of these diseases present nothing peculiar. *Scirrhus* commences as a hard tubercle in the groove under the glans, and thence infiltrates the body of the organ. Its production seems to be predisposed by congenital phimosis. Thus, of twelve patients with this form of cancer, who came under Hey's observation, nine had congenital phimosis. Conversely, the Jews, who are circumcised, are, Travers states, seldom subject to the disease. *Epithelial Cancer* is, Professor Humphry believes, the only form of cancer of the penis. It commences usually on the glans, as a firm, warty elevation, having a broad base. At first painless and covered with a cuticular crust, this being shed or rubbed off, the growth becomes painful, bleeds a little, and soon ulcerates, discharging a thin, fœtid sanguineous fluid. It spreads, destroying the glans, opening the urethra, and involving the prepuce. The inguinal glands become affected, but not distant organs. Occasionally, the prepuce is the seat of this form of cancer. Phimosis here also seems to be a predisposing condition; and the prepuce may be ulcerated through, disclosing the cancerous growth.

Diagnosis.—In the early stage of cancer, there may be some difficulty in distinguishing between a cancerous wart and a common wart, or chancrous induration which has not ulcerated or has cicatrized. But the ulcerative tendency of cancer, and the character of the discharge, with the slow, steady progress of the disease, are diagnostic. The somewhat advanced period of life, and the negative effect of treatment, will also corroborate the nature of the disease.

Treatment.—The only treatment is extirpation; either by circumcision, or by amputation of the organ.

Circumcision should be selected only when the disease is strictly limited to the prepuce; a comparatively rare condition, whether as regards the origin of cancer of the penis, or the stage when this affection usually comes under surgical treatment.

Amputation of the Penis.—This is a very simple operation, yet certain particulars must be observed to insure its satisfactory performance. Amputation may be effected by the knife, or the écraseur; the former instrument being generally preferable. The operation should always be performed near the root of the penis, in order to completely remove the disease. An assistant holds that part of the organ firmly between the thumb and finger, to prevent the liability of its slipping back under the pubes, and to restrain hæmorrhage; then the Surgeon, laying hold of the penis, draws the integument slightly forward, and severs the body of the organ near its root by one sweep of the knife from above downwards. If too much integument be drawn over the stump, it may overlay the urethral orifice; if too little, an inconvenient puckering results. Bleeding vessels are then to be secured; usually, five arteries require ligature,—the two dorsal arteries, the artery of the corpus cavernosum on each side, and one in the septum. The oozing surface of the corpora cavernosa will spontaneously cease to bleed, aided by sponging with cold water; or such hæmorrhage may be restrained by a compress, secured by a T bandage. A tendency to retraction of the stump under the pubic arch must not be overlooked, and a catheter should then be kept in the bladder to insure a free escape of the urine. Granulation and cicatrization close the wound, the skin becoming puckered around the urethral orifice. During and after this process of healing, this orifice has a tendency to contract, resulting in stricture of a most troublesome or even fatal character. To prevent any such result, a catheter should be introduced and kept in the bladder; the silver female catheter, or a gum-elastic one, may be used now that the urethral passage is so much shortened. When an instrument is not easily borne, Mr. Teale's little addition to the operation will be convenient; a catheter is introduced, and the urethra and adjoining skin are slit up with a bistoury to the extent of about two-thirds of an inch. A single suture is then placed on each side of the slit, uniting the skin and mucous membrane. Perfect patency is thus given to the orifice, which has a long, oval form; and after cicatrization has finished, there remains a free opening into the urethral canal, and no mechanical aid will be required. This procedure is applicable also when contraction has taken place from cicatrization after amputation; thereby sparing much trouble and pain in endeavouring to effect dilatation. I have accomplished the same result, by simply inclining the bistoury forwards, in performing the amputation; so as to make an oblique, oval aperture of the urethral termination.

After amputation of the penis, the stream of urine is projected downwards between the legs; and this inconvenience may be avoided, as Paré suggested, by wearing a short funnel, adapted to the pubes over the stump, whereby the urine is carried away from the person.

The *results* of amputation of this organ for cancer have been tolerably successful; especially as regards the epithelial form of the disease. In several instances no return has taken place, even for years; six, eight, ten, or twenty. The disease may, however, return; either in the stump, or in the inguinal glands. The latter may admit of extirpation.

Tumours, of a non-malignant nature, occasionally form in the penis. Thus, *fibro-plastic* growth in the prepuce has been known to occur, invading the corpus cavernosum; and *nævus* under the prepuce.

Malformations.—(1.) Deficiency of a portion of the urethra, laying open the canal from the external meatus, is a not uncommon malformation. It is a congenital condition by arrest of development.

Hypospadias, the most frequent form, is that condition wherein the under part or floor of the urethra is wanting; to the extent usually of the glans, or sometimes as far back as the root of the penis. Through this under fissure, the urine is passed somewhat inconveniently, and the semen is ejected in an unsatisfactory manner during sexual intercourse. When the fissure passes some way back, it may be impracticable to eject the semen into the vagina.

Epispadias signifies the opposite condition: that wherein the upper part or roof of the urethra is wanting, to a variable extent from the meatus, together with a corresponding portion of the glans and of the mesial junction of the corpora cavernosa. The upper fissure is, perhaps, more open than an under fissure; but epispadias is usually less extensive, unless in connection with extroversion of the bladder, and it is certainly a much less common form of urethral deficiency. In a slight case, the Surgeon may well assure an anxious parent that the boy will probably make as good a man as the father.

(2.) *Absence of the Urethra* is occasionally met with, as in extroversion of the bladder; or the canal may be obliterated in a *portion* of its course, or occluded merely by a membranous diaphragm, generally near the vesical orifice; or there may be a second meatus;—a variety of hypospadias, usually about an inch behind the site of the normal one; of which malformation I have seen an instance.

Treatment.—As a rule, it will be best to leave these urethral malformations alone; any such defect probably not having much functional importance, and being little improved by any operative procedure. When, however, the urethral deficiency exists to an extent which practically renders the person impotent, the hypospadias or the epispadias may perhaps be remedied by a plastic operation. The edges of the opened portion of urethra should be pared, and brought together by suture, over a catheter. Narrowing of the urethra may be dealt with by dilatation; and a membranous diaphragm perforated by a trocar, when its existence has been clearly ascertained.

CHAPTER LXVI.

DISEASES OF THE SCROTUM, TESTIS, AND CORD.

DISEASES OF THE SCROTUM.—INFLAMMATORY ŒDEMA of the scrotal integument is an affection of an erysipelatous character; and, owing to the loose structure of the subcellular tissue, it is attended with great effusion and swelling, with a marked tendency also to rapid sloughing. The skin becoming involved, the testicles and cords are soon exposed; and these organs may even hang pendulous, entirely bereft of integument.

This affection is liable to occur in enfeebled persons, from any slight local cause of irritation; as a small wound, crack, or abrasion; a boil or small abscess in or near the scrotum. Apart from the predisposing constitutional condition, sloughing of the scrotum rarely supervenes. Thus, the scrotum is very seldom the seat of mortification from frost-bite; although such cases have been seen by Sir A. Cooper and Mr. Curling.

Treatment consists in elevation of the scrotum, with fomentations; and early, free incisions, on either side of the raphé, down to the most dependent parts of the swelling. Tension is thus relieved, and the tendency to sloughing. In the event of this issue, granulation and cicatrization proceed apace even after the most extensive exposure. Constitutional treatment must be conducted on ordinary principles, for sustaining the patient's strength during the consecutive processes of destruction and reparation.

Anasarca of the scrotum, in old, weak persons, should be met by puncture, rather than by incision.

Œdema of the scrotum, in newborn infants, often happens in consequence of some slight irritation of the skin. It subsides usually under careful attention to keep the part dry and powdered. Death, however, may ensue; a result which Professor Humphry witnessed in one case, and of which he cites two such cases.

ELEPHANTIASIS.—This term has been used to signify at least two different diseases: the *elephas* of the Greeks,—known also as *leprosy* or lepra in the Old and New Testaments; and the *elephantiasis Arabum*, as more commonly referred to. The one is a constitutional disease; the other a local affection, seated either in the leg, and then known as Arabian elephantiasis—the Elephant-leg, or leg of Barbadoes; or in the scrotum—forming the elephantiasis scrotal tumour or Egyptian sarcocele, tropical bucnemia, spargosis, etc. In order to avoid confounding diseases which are distinct in themselves, it will be convenient to consider "Elephantiasis" as a generic term, before describing the latter or Arabian disease, as affecting the scrotum.

ELEPHANTIASIS GRÆCORUM.—Leprosy is described by Dr. Vandyke Carter, as making its first appearance in the form of a circular spot, having a raised margin, not scaly, and a depressed atrophied centre, which is insensible; this spot is also remarkably indolent, but of a spreading character. This "leper-spot" is said to have the same relation to the development of leprosy that chancre—as the local or primary lesion—has to secondary or constitutional syphilis. But it would seem that the *nerves* of the leper-spot are primarily and essentially affected; and that the disease thence spreads along the course of the nerves, which become infiltrated with a peculiar deposit, so that they may acquire twice their natural size. Our friend Dr. Druitt, who, during his late residence in Madras, particularly studied Elephantiasis, thus observes of this deposit:—"It seems to invade the nerves as soon as they pierce the fascia, and they can often be felt under the skin, as rounded cords, perhaps nodulated; deeper trunks are affected later. The consequences of this nerve-disease are the same as when nerves are irritated by injury, *i.e.*, loss of sensation in the skin—lepra *anæsthetica;* atrophy of the skin, which loses its hair; bullæ of pemphigus, which often lead to deep ulcers; atrophy of the muscles, and of the bones, beginning with those of the last joints of the fingers or toes. The bones first become thin and slender, then absolutely vanish by absorption, so that the finger-nails may be found on the ends of the metacarpal bones, the parts between them having disappeared. This process of mutilation is often hastened by abscess and necrosis of the bones." The same author describes "the most hideous form of leprosy as the so-called tubercular—lepra *tuberculosa*—in which there is an eruption of rounded, flattened patches on the eyebrows, ears, and surface generally, giving in bad cases an extraordinary animal aspect to the face; the forehead swollen, the hairless eyebrows protruding, the ears projecting forward and of enormous size, the upper lip pouting and swinish, the nose first flattening and then falling in." These three forms of leprosy—skin, nerve, and tubercular leprosy—are often combined in the same person. Then, indeed, being afflicted with a spotted skin-eruption, or with crops of tubercules, disfiguring the features to a degraded expression, while the arms and legs are paralyzed and distorted, the confirmed leper was ever shunned, save by Him whose compassion embraced all mankind.

The *causes* of leprosy are but little understood. As a constitutional disease it may be ranked with scrofula and syphilis. It seems to be hereditary, although not manifested perhaps until adult life, from twenty to thirty years of age. The disease is probably contagious; and it may be communicated by various articles of food, milk in particular, and especially the milk of the buffalo. Climate appears to have no restrictive influence on the development of leprosy, for it is found in cold latitudes, such as Norway, as well as under the Equator; but, owing probably to habits of life, as with regard to uncleanliness under a hot climate, the disease has ever prevailed in Eastern countries. From the period of the Middle Ages, leprosy has died out in this country; having appeared in Scotland after it was extinct in England, and was last seen in Shetland. ("Edin. Med. Journ.," 1841; "History of Lepers," etc., by Sir James Simpson.)

Treatment.—Although leprosy is a very *chronic* disease, continuing perhaps for many years, it does not seem to have any inherently fatal tendency,—the poor sufferer dying at last rather from some contingent affection, such as diarrhœa or albuminuria. On the other hand, the disease responds hardly to any remedial measures. Druitt informs us that at present there are three medicinal agents under trial,—the gurjun oil, recommended by Dr. Dougall; the chaulmoogra oil, which Dr. Bhau-Dagi advocates; and the Neradee muttoo. They are all oleo-resinous drugs; and, mixed with lime water, are used as embrocations, and administered internally, in the cases of leprosy at Madras. But according to the experience of Dr. Van Someren, of the Leper Hospital, and the opinion also of Dr. Macrae, cleanliness and a good diet are more efficacious than any other treatment.

Elephantiasis Arabum.—*Signs.*—In the form of the *Elephant-leg*, Arabian Elephantiasis is very readily recognized, from its remarkable resemblance to the foot of the elephant, and the marked difference of the diseased appearance from that of any other morbid condition. The human leg is converted into a greatly enlarged, hard, tuberous, thick-skinned mass, the integument often marked by transverse folds, and the whole having a dark colour and a broad base, like the foot of the animal with which it is compared. Sometimes the pachydermatous surface is fissured, or beset with small, pearly crusts; and it is liable to ulceration, spreading both in depth and breadth. The elephantine integument gradually loses its sensibility. Thus, in the developed state of this disease, the appearances are quite characteristic. In the early stage, the signs are those of chronic inflammation of the skin and subareolar texture; the foot is reddish and tender, encased with a semi-solid œdema, which renders any movement of the part stiff and painful. But what is more significant, in some cases, is the appearance of reddish-purple, branching streaks, in the course of the lymphatic vessels, coupled with tender swelling of the proximate lymphatic glands; as if a certain amount of lymphatitis and adenitis were associated with the œdema. Then, also, there is more or less febrile disturbance in connection with the otherwise local affection of the foot and leg.

The *structural conditions* in the developed form of elephant-leg may be comprised under the general term hypertrophy of the skin and its papillæ, with the cuticle and the subcutaneous cellular texture, resulting from infiltration with a peculiar fibroid matter of a firm, inelastic character. Thus, the skin may become increased in thickness to half an inch or more, and the papillæ tufted; the epidermis is simply thickened, and almost inseparable from the cutis; but the areolar texture under the skin is also the seat of the fibroid deposit, acquiring the same dense, inelastic consistence. A section from the surface presents a whitish, fibroid texture, associated perhaps in the areolar spaces with a thick gelatinous matter. Deeper still, the muscles are found to be atrophied or wasted, and to have undergone a pale-yellowish softening,—in short, fatty degeneration. The blood-vessels are thickened and enlarged, so as to bleed freely during life; the nerves, enlarged in size, have a flattened, compressed appearance; and even the bones may have became enlarged in circumference and denser in texture, or hypertrophied. But the most noteworthy change may be the hypertrophic condition of the lymphatics, associated perhaps with a beaded varicosity of these vessels. They are distended with a milky, lacteal fluid, like chyle. Miscroscopic examination shows that the fibroid deposit consists of immature fibres, combined with an abundance of lymph-cells, in various stages of development into fibres.

Taking the clinical appearances of lymphatitis in connection with this increased production of lymph-cells, it would seem that such may be the essential and initial change in the pathology of elephantine disease; giving rise to a species of fibroid hypertrophy of the part affected—allied to a fibrous tumour of the skin and subareolar tissue. In relation to the influence of climate, it should be observed that this form of elephantiasis is common in Eastern countries, such as Arabia, India, Asia, and Africa, but is rarely seen in any part of Europe. It is a disease more often of early or adult life than of old age; and it occurs more frequently in males than females.

The course of this disease presents few changes to be noticed. Remaining probably for life, an elephant-leg may undergo no further enlargement during many years; or it may grow steadily until it attain an enormous bulk and weight, amounting perhaps to fifty, seventy, or even one hundred pounds. But beyond the encumbrance thus occasioned, the general health is little disturbed, until ulceration takes place, and a draining purulent discharge, under which the patient may sink exhausted.

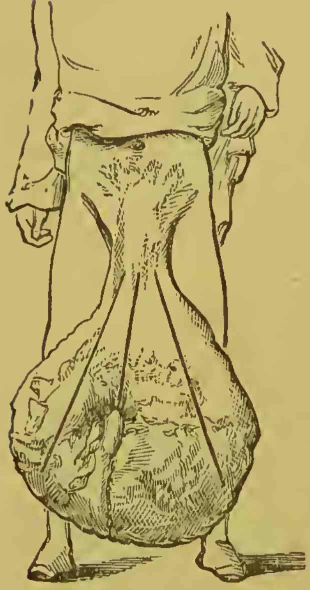
In regard to the *treatment* of elephantiasis, but little can be done. The appropriate remedies for chronic inflammation are the most hopeful. Thus, in an early stage, topical bleeding by leeches or scarification may have some beneficial effect. But as the solid œdema supervenes, this must be reduced, if possible, by stimulant applications; as by encasing the leg with a blister, or by painting with iodine pigment, repeated occasionally. The combined advantage of pressure with stimulation may be tried by means of strapping with the emplastrum ammoniacum cum hydrargyro; and the various preparations of iodine and mercurial ointments may be employed by inunction. An irritant plan of treatment has, however, the disadvantage of perhaps provoking ulceration of the leg, the ulcer being obstinately indisposed to heal. Compression of the limb, simply by bandaging, might therefore be more judicious. And, in any case, an elevated position, for the relief of tension, should not be overlooked. These local measures may be aided by the constitutional influence of mercurials. No satisfactory results have hitherto attested the efficacy of thus attempting to arrest the growth of elephantiasis. It has been proposed to ligature the main artery of the limb—the femoral, in order that, by withholding the supply of blood, the hypertrophied part may cease to grow, and become atrophied. But the free collateral circulation, owing to the enlarged state of the blood-vessels throughout the limb, would alone render the propriety of this operative procedure very doubtful. In the few instances where it has been resorted to, the results, I believe, have not been very encouraging.

Elephantiasis or Hypertrophy of the *scrotum* rarely occurs in this country, but is very common in tropical climates; especially China, India (East and West), Egypt, and South America. It consists of a fibroid thickening of the scrotal integument, with infiltration of serum or oily matter; the latter being sometimes so abundant as to give to the whole the character of an oleaginous mass. The blood-vessels become much enlarged and varicose, so that the fibroid structure is remarkably vascular. The cremaster has been found thickened, and the spermatic cords elongated; but the testes are usually healthy. Hydrocele occasionally coexists, or sometimes scrotal hernia. The whole mass is pendulous, and of a globular, ovoid, or pyriform shape.

Causes.—A low chronic inflammation would seem to be the origin of this disease; and it commences either at some one point, thence spreading gradually over the scrotum, or as a tumefaction of the whole bag. There may be some locally exciting cause, as a fistulous tract; more frequently, no source of irritation can be traced.

The part may remain smooth, or become tuberculated and corrugated; in either case, it has little or no tendency to ulcerate, unless in consequence of abrasion. Slowly increasing, without pain, the scrotal hypertrophy often attains an enormous bulk (Fig. 940), and weighs 50, 100, or even 150 pounds; ultimately proving fatal by its distressing weight, or perhaps by the supervention of ulceration and incessant ichorous discharge. Sometimes, the mass falls into a state of gangrene, and thus the patient dies, as in a case related by Hendy. Ichthyosis not unfrequently coexists in other parts of the body. Cases of Elephantiasis of the scrotum have been recorded by Clot-Bey, of Egypt; by Liston, Key, Sir W. Fergusson, Mr. Isaacson, Mr. Brett, Mr. Haynes Walton, and Mr. Wiblin, of Southampton; while numerous examples have been contributed, principally from the experience of Delpech, Larrey, Titley, Picton, Thebaud, Bozeman, O'Farrall, and Fayrer.

FIG. 940.*



Treatment.—In the early stage of this disease, it may perhaps be arrested by pressure and other means of allaying chronic inflammation of the skin. Such treatment failing to take effect, recourse must be had to the operation of excision, without delay.

Excision.—When the tumour is of moderate size, the testes and penis may be dissected out and saved; the hæmorrhage not proceeding to a dangerous extent. When the tumour has attained to a large size —forty pounds and upwards—it must be excised *en masse*, including the genital organs; the hæmorrhage of a partial excision would be so profuse as to be fatal during the operation; and even with the rapidity of complete excision, patients have sunk from loss of blood. To prevent the risk of hæmorrhage, a clamp should be applied to the neck of the tumour, or a cord ligature, or the tumour may be raised for half an hour before the operation, in order to drain back the blood into the general circulation. In Mr. Walton's case, the scrotum was first tied in small segments close to the trunk, and the mass removed below the ligatures; then, as each strangulated part was liberated, the vessels were secured. The scrotum weighed eight or nine pounds, and the patient recovered.

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* From photograph to Author, by Sir Joseph Fayrer.

The general *results* of excision in this disease are shown by 161 cases wherein Mr. Esdaile, of Calcutta, operated, with the loss of only five per cent.; and in no instance was death directly due to the operation. In 113 cases submitted to excision in the Medical College Hospital of Calcutta, twenty-one died, or a percentage of 18·58. The large size or weight of the mass removed may not occasion an unsuccessful result; Clot-Bey having had four successful cases, where the weight of the tumour removed was, severally, 65, 70, 80, and 110 pounds. The causes of death have generally been hemorrhage, shock, exhaustion, pyæmia, or diarrhœa; and peritonitis, in one or two cases, by inflammation extending up the spermatic cord.

TUMOURS of the scrotum are rare. *Fibrous* tumour has, however, been known to occur in several instances, collected by Mr. Curling. It originates in the areolar tissue, is painless, and grows slowly; attaining sometimes to the enormous size of twenty or thirty pounds, and upwards. This species of scrotal tumour occasionally undergoes calcification; and some have been of the recurring fibroid variety. The ordinary fibrous growth has been removed successfully, even when of the largest size. *Fatty* tumour of the scrotum is far more uncommon; and *Cystic* tumour is quite rare. Professor Humphry has met with only two recorded cases. Both the latter kinds of tumour have proved very difficult of diagnosis. Large *calculi* have every now and then been known to find their way from the bladder into the scrotum; thence escaping by ulceration or being excised.

Cancer of the scrotum is generally of the *epithelial* kind, and this occurs mostly in chimney-sweeps. Hence the disease has been named *Chimney-sweeper's cancer*, or *soot-cancer*. It appears to arise from the constant irritation by soot lodging in the folds of the scrotum, and is a common affection. Commencing usually between the ages of thirty and forty, rarely before puberty, it appears as a flattened soft tubercle or wart of a leaden hue, and situated generally near the lower and fore part of the scrotum; this little lump slowly spreads, becomes indurated and covered with a crust or by a thick horny concretion. Occasionally, more than one such lump may form. Ulceration takes place, and an uneven open surface is exposed; having a sinuous edge, with a hard tuberated border and an indurated base, discharging a thin bloody fluid. Ultimately, the whole scrotum is destroyed, exposing the testicles, which are usually spared; and the inguinal glands become indurated. Death ensues from constant pain and continued discharge, and in a period averaging four or five years. The disease is then found to be a nearly local affection, not invading the lumbar glands or the abdominal viscera.

Treatment.—Free excision affords the only hope of cure, and this in proportion to the limitation of the disease. When it returns, the operation may be repeated; and again and again, even to the removal of the whole scrotum and testes, provided such free excision can remove the whole of the disease. Induration of the inguinal glands is no positive bar to the operation; for slight induration may afterwards subside or remain quiescent; while with greater induration and enlargement, these glands can perhaps be dissected out as part of the disease and operation of excision.

DISEASES OF THE TESTIS AND CORD.

Associated with the Testis and the Scrotum, the TUNICA VAGINALIS, intervening between the two, may be the seat of certain diseased conditions: *Hydrocele*, and *Hæmatocele*, in their ordinary forms, as signifying either an accumulation of serous fluid, or an effusion of blood, within this serous sac. The spermatic veins are liable to varicose enlargement, forming *Varicocele.*

Diseases of the TESTIS and CORD specially comprise five generic conditions:—(1) *Inflammation* or *Orchitis* and *Epididymitis;* (2) *Chronic Enlargement—Syphilitic* and *Scrofulous*; (3) *Tumours*,—Fibrous, Cartilaginous, Cystic, Cancer; (4) *Atrophy* of the Testis; (5) *Functional Disorders*—Impotency, Spermatorrhœa, Neuralgia; *Congenital Malposition* of the Testis.

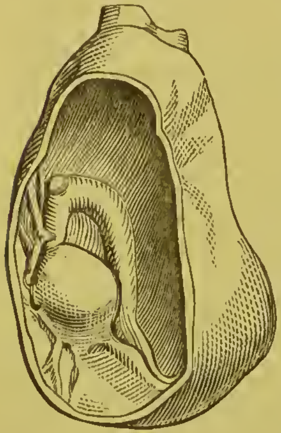
HYDROCELE.—In the widest acceptation of the term, Hydrocele signifies an accumulation of serous fluid, in connection with the Testis or Spermatic Cord.

Ordinarily, the fluid is collected in the tunica vaginalis, enveloping the testis; sometimes, in a cyst or cysts, variously situated relatively either to the testis, or in the course of the spermatic cord. Hence, Hydroceles may be divided into that of the *Tunica Vaginalis Testis;* and the *Encysted* forms, as relating either to the Testis or to the Cord.

An accumulation of serous fluid in the tunica vaginalis may occur in two conditions of the sac; either when the vaginal process of peritoneum has become obliterated, whereby the fluid is contained in a distinct sac,—constituting the *common* form of Hydrocele; or when that tubular prolongation of peritoneum remains unobliterated, so that the fluid is contained in a sac which communicates with the general peritoneal cavity,—constituting *Congenital* Hydrocele.

Hydrocele of the Tunica Vaginalis.—The serous fluid is accumulated in a distant sac, enveloping the testis; and this organ, somewhat enlarged, is usually situated at the lower and back part of the sac. (Fig. 941.) Sometimes the testis is flattened and spread out by constant pressure of the fluid; and the epididymis is then elongated, obliterating the pouch which naturally exists between the testis and epididymis. Or, the testicle may be separated from the back part of the sac by an increase of this pouch, which forms a second sac communicating with the general sac of the tunica vaginalis, between the testis and epididymis. Lastly, the testis may occasionally project into, and transversely across, the hydrocelic cavity; forming a septum whereby the sac is divided into two compartments. The position of the testis is sometimes changed to the lower and fore part of the sac, or it may lie wholly in front. The serous fluid is simply the natural secretion of the tunica vaginalis, or slightly modified by inflammation. Clear, and

FIG. 941.*



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* Roy. Coll. Surg. Mus., 2326. A large hydrocele of the tunica vaginalis, showing the position of the testicle on the posterior wall, about one-third from the fundus of the sac. There are two small pedunculated bodies on the upper part of the epididymis. (Hunterian.)

of a pale straw colour, this fluid often acquires a dark-brownish or chocolate hue, in an old hydrocele, or rarely it has a white milky colour; in both cases becoming less transparent or opaque. In its composition the fluid is albuminous, alkaline, and saline; but there may be associated fibrine in variable proportion, as indicated by spontaneous coagulation; or red corpuscles of the blood, in a disintegrated state, when the fluid is dark coloured, with perhaps also flakes of cholesterine; or products of inflammation occasionally, as flakes of lymph. In point of quantity, the fluid of hydrocele varies from six to twelve or twenty ounces, averaging less than a fluid pint; but it may have accumulated to double or treble that amount. The largest quantity I have ever tapped from a hydrocele measured fifty-two ounces; the largest quantity on record was that removed from Gibbon, the historian, whose hydrocele, when tapped by Mr. Cline, yielded six quarts!

Signs.—A collection of serous fluid in the tunica vaginalis is attended with a swelling on the affected side of the scrotum, which presents certain distinctive characters. This swelling is at first soft and fluctuating under compression with the fingers, but it becomes tense and elastic as the sac is distended; it is translucent when examined by transmitted light. Increasing in size according to the quantity of fluid secreted, the swelling varies in magnitude from a hen's egg to a small cocoa-nut; occasionally, it attains to a size which, dragging over the penis, buries that organ, and extends downwards to or towards the knees. In point of shape, the swelling is at first oval; enlarging, it becomes pyriform with the large end downwards, thus corresponding to the shape of the distended tunica vaginalis; and there is often a slight transverse constriction about the middle of the tumour, apparently due to the lower border of the cremaster muscle, which thus gives an hour-glass appearance to the hydrocelic swelling. Little or no pain is experienced, only some tenderness in the testicle or epididymis; and a sense of weight or dragging-down as the hydrocele enlarges.

The mode of examining a hydrocele is very simple. Having handled the swelling to ascertain its fluid character, by fluctuation or elasticity, the translucency may be shown by grasping the posterior part of the tumour, so as to render the integument of the fore part tense; then placing a lighted candle on the one side of the tumour and looking through it from the opposite side, at the same time screening any direct light from the eye, by resting the hand edgewise along the front of the scrotum.

Varieties of Hydrocele are met with, in consequence of changes in the sac, or the contained fluid. These changes are chiefly found in *old* hydrocele. *Thickening* of the sac often takes place, the tunica vaginalis acquiring the resistance of pasteboard; sometimes it becomes cartilaginous, or even osseous by the formation of bony plates on its interior. A *bilocular* or *multilocular* condition of the sac sometimes occurs; either as a result of pouch-like dilatations (Fig. 942), or of inflammmatory adhesions of the interior and the formation of septa, dividing the sac into two or more compartments. The *serous fluid* is liable to undergo the changes of colour and opacity already noticed.

Under these circumstances, fluctuation and translucency of the tumour become less and less marked as signs of hydrocele. The test by transmitted light may, however, yet be available when the examination is conducted in a darkened room.

Hydro-sarcocele signifies that variety wherein the testicle itself is much enlarged in conjunction with hydrocele.

Diagnosis.—Hydrocele is distinguished from *scrotal hernia,*—by the translucency of the swelling, when this sign is present; by the tumour terminating abruptly at the external abdominal ring, instead of extending with a thick stalk upwards into the inguinal canal; by the sharp angle formed at the external ring, and hinge-like movement of the tumour, when it is tilted forwards; by the absence of impulse at that point, on coughing; by the lighter weight of hydrocele; and by the history of its development, as to whether the swelling commenced below, in the scrotum and ascended to the groin, or descended into the scrotum. The two conditions—hernia and hydrocele—are not unfrequently *coexisting* (Fig. 943); the hernial sac descending into the scrotum, in front or behind the hydrocele, on one side of it, or sometimes into the hydrocele. Out of six cases of the latter relative position which Dupuytren witnessed, in two only symptoms of strangulation resulted from constriction of the hernia at the line where it was engaged in the serous pouch of the hydrocele. From *cystic disease of the testicle*, hydrocele may be distinguished by the fluctuation extending all over the swelling, instead of being limited to some part of the tumour. From *hæmatocele*, or a collection of blood in the tunica vaginalis, hydrocele is known by its translucency; when non-transparent, recourse must be had to the aid of puncture by a trocar, as the turning-point of diagnosis.

FIG. 942.*

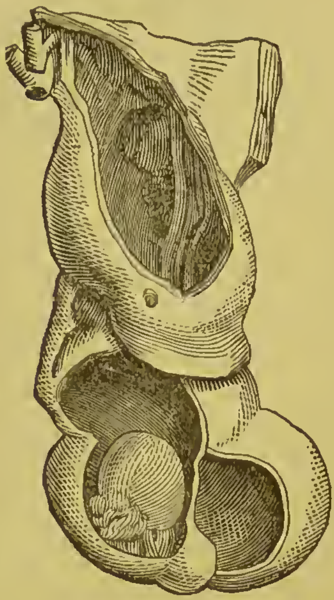
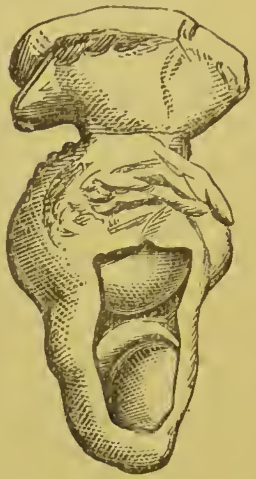


FIG. 943.†



Double hydrocele, one on each side of the scrotum, occurs in about an equal number of cases.

Causes.—The serous fluid in the tunica vaginalis—forming hydrocele—is only an excessive quantity of that which naturally moistens the internal surface of the tunic; and its accumulation results from loss of balance between secretion and absorption. This change seems to be dependent on long-continued irritation, and often arises from a blow or other external violence. One of the largest hydroceles I ever knew was produced by a blow from a cricket-ball. Inflammation may also be induced in like manner; giving rise to hydrocele, and an effusion of lymph mixed with the serous fluid. Hydrocele occurs most frequently about middle life, and in persons of a weakly constitution, or an enfeebled state of health.

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* Roy. Coll. Surg. Mus., 2335. Complete septum in tunica vaginalis testis, and hydrocele of each sac. Above this bipartite tunica vaginalis, there is the sac of an old inguinal hernia. The hydrocele had existed twenty-five years, and the patient died at seventy years old, after an operation for strangulated hernia. (R. B. Walker.)

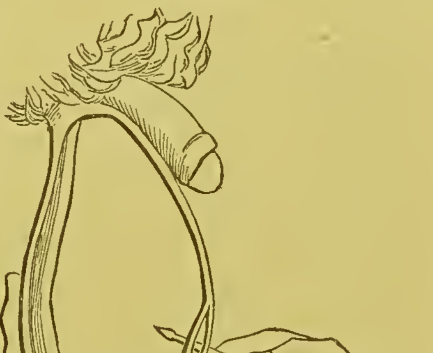
† Ibid., 1337. (Hunterian.)

Treatment.—Arrest of the secretion, and resorption of the serous fluid, cannot be induced by any known medicinal treatment, topical or constitutional. In this respect, hydrocele resembles similar effusions in hydrocephalus, hydrothorax, hydrops articuli, etc.

The treatment adopted may be *Palliative*, by tapping; or *Curative*, by tapping, and the injection of some stimulating fluid to induce inflammation or inflammatory adhesion; or, as a last resource, by the introduction of a seton for the same purpose.

Palliative Treatment.—Tapping a hydrocele is performed by means of a fine trocar and cannula, in the following manner. The Surgeon having ascertained the position of the testis, usually at the lower and back part of the scrotum, he grasps the posterior part of the tumour so as to make tense the skin in front; then, selecting a spot about the middle of the projecting surface, and in an interspace between the veins, he thrusts a fine trocar and cannula in a perpendicular direction backwards into the hydrocele, taking care not to push the instrument so far back as to wound the testicle, when the hydrocele-sac yields suddenly before the point of the trocar. (Fig. 944.) The object of thus avoiding the veins, and of directly transfixing the skin and sac of the hydrocele, is to prevent any effusion of blood into the intervening cellular tissue, which might lead to sloughing; while the testicle is avoided by observing the precautions in handling the tumour, and as to the limited depth of the instrument. On withdrawing the trocar, the fluid is drawn off through the cannula, which is then itself withdrawn, and the puncture-spot covered, if necessary, with a small piece of plaster.

FIG. 944.



The relief afforded by this procedure is, usually, only temporary; the fluid is almost certain to re-accumulate in the course of a few months. Tapping may then be repeated, and on several subsequent occasions, whenever requisite to relieve the weight and inconvenience of the hydrocele. In healthy subjects and small hydroceles, palliative treatment, by a single or repeated tapping, sometimes proves a radical cure.

Curative Treatment.—This may be effected by means of a stimulating injection, or by the introduction of a seton.

Injection.—Tapping having been performed as already described, some stimulating fluid is injected through the cannula by means of a small glass syringe. Various fluids have been used—port wine, spirits of wine, sulphate of zinc in the proportion of a drachm to the pint of water; but the most effectual kind of injection is tincture of iodine, to the amount of two or three drachms. The injection may be allowed to remain in the sac; or allowed to escape, after the lapse of a short period varying from a few minutes to half an hour, according to the practice of some Surgeons.

Two practical points should be observed in using the injection: firstly, that the slit in the cannula be completely within the tunica vaginalis, before throwing in the fluid: secondly, while withdrawing the cannula, the sac should be nipped against it between the finger and the thumb. Both these precautions are with the view of preventing any escape of the injection into the cellular tissue between the skin and sac; an accident which would probably be followed by diffuse inflammation and sloughing, particularly in a weakly patient.

The immediate effects of injection are more or less severe; pain, extending up the cord into the abdomen, and perhaps attended with faintness; a transversely puckered appearance of the scrotum I have also seen produced, by contraction of the dartos, and some degree of priapism.

After-treatment is simple. The patient should rest for a few days. In the course of twenty-four hours, inflammatory effusion will have taken place into the sac, and the swelling may be reproduced to nearly its original size, looking almost as if the hydrocele had not been tapped. This is a good sign, announcing the probability of a radical cure ensuing. The degree of pain produced is no criterion of the curative efficacy of injection. At the time of operation, sudden and severe pain may be excited immediately the stimulating fluid touches the tunica vaginalis, and which becomes excruciating; yet without much, if any, inflammation being induced. Conversely, there may be little pain and much inflammation. According to the degree of inflammatory swelling produced, it will be necessary to regulate the process; by handling the scrotum on the affected side to promote effusion, or by cold lotions to moderate it. Orchitis, to some extent, accompanies the inflammatory effusion within the sac; thus presenting a mixed swelling, œdematous to the touch superficially, hard and tense when felt deeper. In a few days, also, as the scrotal swelling subsides, that of the testicle becomes more obvious.

The cure of hydrocele seems to be effected in two ways: either in consequence of adhesive inflammation, whereby the cavity of the tunica vaginalis is obliterated more or less completely; or by the mere passing of inflammation upon this membrane, whereby its secretory power is so modified as to restore the balance between absorption and secretion of the serous fluid which naturally lubricates the surface of the tunic. Failures occur, either by an absence of inflammation, or by an excess, with undue effusion or deficient absorption of the superfluous effusion, the tunica vaginalis remaining distended with fluid. Suppuration very rarely supervenes; Sir B. Brodie witnessed it in three cases, and Mr. Curling has seen one such case. Occasionally, the hydrocele has returned, and then gradually disappeared. But generally the cure by injection is permanent, entitling it to be designated the *radical* cure of hydrocele; although sometimes the fluid has returned after a lapse of years.

The *results* of iodine injection have been very satisfactory, both as regards its safety and success in the cure of hydrocele. It excites inflammation of a moderate and uniform degree, rarely very severe, yet generally sufficient for the purpose. The proportion of failures has been variously estimated; in India, where iodine injection was originally introduced by Sir R. Martin, the failures scarcely amount to one per cent.; in France, Velpeau calculates them at three per cent. In this country it has also proved very successful.

Seton.—The cure by the passage of a seton should be reserved exclusively for the few cases wherein injection has failed. After tapping the hydrocele, a long needle, armed with a seton of silk, is passed up the cannula and drawn through the upper part of the scrotum; then the cannula is removed, the needle cut off, and the thread knotted loosely. This is allowed to remain until sufficient inflammatory effusion has been excited; usually, in a period varying from twenty-four to thirty hours, but sometimes extending to ten or twelve days. Little inflammation may have ensued, yet a radical cure may result. But intense orchitis and prolonged suppurative discharge from the tunica vaginalis are not unfrequently induced by this method of treatment, and my experience of it is very unfavourable.

The radical cure—whether by injection or seton—should be practised only under certain circumstances, with regard to the size of the hydrocele and the patient's state of health or age. These precautions are necessary in relation to the safety and efficiency of the radical cure.

Large hydroceles—one, for example, containing a quart of fluid—should not be injected; the consequent inflammation of so large a sac might prove overwhelming and terminate fatally. Such a hydrocele may be tapped; and in a short time emptied again, when the sac has become contracted; then this smaller-sized sac can be safely and effectually injected. An enfeebled state of health, or persons advanced in life, should not be subjected to the risk incurred by injection. Tapping may be resorted to as occasion requires.

Congenital Hydrocele presents a few points of importance with regard to its diagnosis and treatment.

The vaginal process of peritoneum remaining open, as a tubular prolongation communicating with the general peritoneal cavity, this condition of the hydrocelic sac gives rise to certain characters, which distinguish it from ordinary hydrocele and from scrotal hernia. The serous fluid accumulated in the sac can be returned by pressure into the abdomen, especially in the recumbent position; and the sac gradually refills again, when the pressure is removed from the external abdominal ring and the patient stands up. In both these respects, congenital hydrocele essentially differs from common hydrocele. But it resembles hernia. This may, however, be distinguished by its opacity; and in the non-congenital form of hernia, by the more perceptible presence of the testicle at the lower part of the scrotum.

Treatment.—*Repressive* measures, by cold lotions and mild aperients, may sometimes cause the swelling to subside. When repression fails, the hydrocele should be emptied of its contents into the abdomen, by gently compressing the scrotum on the affected side, and a truss applied to the external ring, as for inguinal hernia. The process of peritoneum may now undergo contraction and become obliterated; thus reducing the sac to that of a common hydrocele. Then, in this state, *tapping*, or with *injection* as the radical cure, may be practised. In cases where the testicle has not descended, the treatment by obliteration of the vaginal process of peritoneum, and injection, will obviously be inapplicable.

Encysted Hydrocele.—This form of hydrocele consists in the production of a cyst or cysts, containing a thin watery fluid; and projecting from some part of the testis (Fig. 945) or epididymis (Fig. 946). It differs from common hydrocele in its relation to the testicle; being situated above or below, or to one side of, this organ, instead of enveloping it. Sometimes, however, the cyst projects into the sac of the tunica vaginalis, distending it as if the fluid were contained in its cavity. Two very rare formations of encysted hydrocele are worthy of notice, as relating to the testis; one, in which a cyst forms between the tunica vaginalis and the tunica albuginea; and the other, in which a cyst is produced within the wall of the tunica albuginea itself, distending it into a cavity enclosing the cyst. (Fig. 947.)

FIG. 945.*

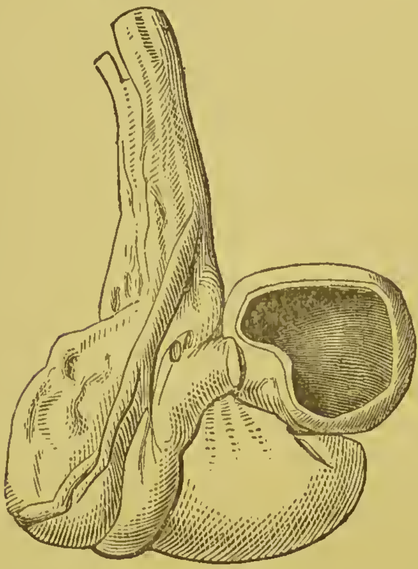


FIG. 946 †

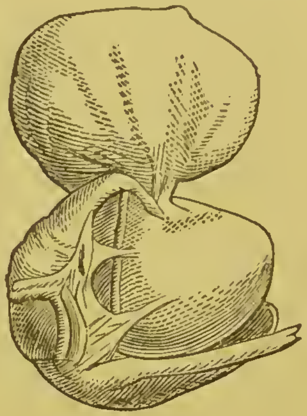
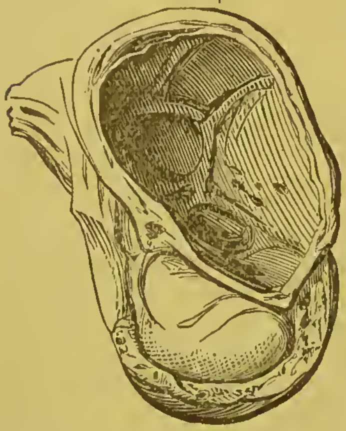


FIG. 947.‡



The *signs* of encysted hydrocele are, as in ordinary hydrocele, a swelling, fluctuating and transparent, but having the above-mentioned different relations to the testis; and as the cyst increases, the testicle is borne upon its wall, thus further altering the relative position of the organ. The fluid contained in the cyst is of a thin watery character, instead of being a yellow serous fluid; and it is remarkable for abounding in spermatozoa—a peculiarity discovered by Liston. In both these particulars, the fluid of encysted hydrocele differs from that of ordinary hydrocele. When this cyst projects into the tunica vaginalis, simulating common hydrocele, the only possible distinction may be the nature of the encysted fluid, as shown by puncturing with a trocar. A tumour of slightly *solid* consistence might yield the sensation of a cyst; *e.g.*, a myxoma of the epididymis. A rare specimen of this kind will be found in the Museum of the Royal College of Surgeons (2392B), as presented by Mr. Gay.

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* St. Thomas's Hosp. Mus., E. 69. Encysted hydrocele of large size.

† London Hosp. Mus., E. *f.* 116. Encysted hydrocele of the tunica vaginalis. The cyst springs from the upper part of the epididymis.

‡ Ibid., E. *f.* 101. Encysted hydrocele of the tunica albuginea of testis. The cyst is the size of a hen's egg, and its walls are from one-eighth to one-quarter of an inch in thickness, alveolar and sacculated from the exudation of plastic matter. (J. Hutchinson. See also "Trans. Path. Soc.")

Treatment is precisely the same as that already described. The radical cure, by iodine injection, is not so uniformly successful as in ordinary hydrocele; but, if it fail, incision of the cyst has been recommended, in order that it may granulate from the bottom and thus become obliterated. Encysted hydrocele may sometimes be left alone; the cyst attaining to a certain size, and then remaining stationary for years.

Encysted hydrocele may be *conjoined* with an ordinary hydrocele of the tunica vaginalis, forming a bilobed tumour or swelling; but having an elastic, fluctuating character. (Fig. 948.) In the specimen I have figured, the tumour is associated with a large *inguinal hernia;* the sac being above the compound hydrocele, and separate. The spermatic vessels are spread out on the anterior aspect of the hernial sac.

Fig. 948.*

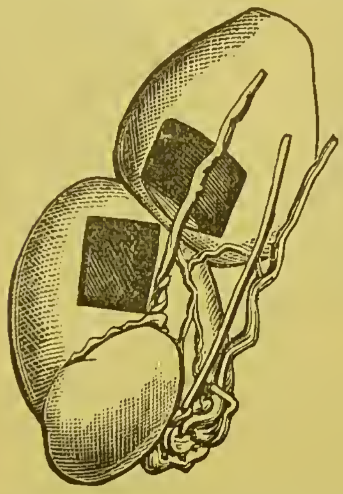
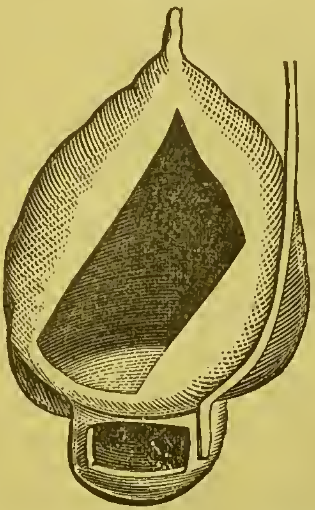


Fig. 949.†



Hydrocele of the Spermatic Cord.—This form of hydrocele is characterized by the presence of a cyst, containing serous fluid; and situated in some part of the spermatic cord. (Fig. 949.) It may be near the testicle, or within the inguinal canal and near the internal abdominal ring; or at any intermediate point. But the cyst is always distinct from the testicle or the tunica vaginalis.

The *signs* are those of a round or oval tumour, rarely attaining to a larger size than a hen's egg; elastic, and translucent when it can be examined by transmitted light. It is movable, unaffected by compression, and receives no impulse on coughing; unless situated in the inguinal canal, when—owing to its mobility up and down the canal, according to the recumbent or standing position of the patient—the apparent diminution under compression, and some impulse on coughing, will render the diagnosis from inguinal hernia most difficult.

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* Roy. Coll. Surg. Mus., 2337. (Sir A. Cooper.)

† Ibid., 2458. Hydrocele of the spermatic cord; the cyst having nearly a globular form, and being almost five inches in diameter. The vessels of the cord pass over its posterior aspect. The tunica vaginalis testis is seen below. (Sir A. Cooper.)

The formation of any such cyst in the spermatic cord seems to be generally due to an unobliterated portion of the vaginal sheath of peritoneum which accompanies the cord; and which, at that part, becomes distended by an accumulation of fluid in it. Sometimes the cyst arises as a distinct cystic formation, connected with the cord. Hydrocele of the cord occurs most frequently in children or young boys; although it may be met with at all ages.

Treatment should be conducted on the same principles as for other hydroceles, by tapping and stimulating injection, or the introduction of a seton; or by an incision to induce granulation from the bottom of the cyst.

Diffused hydrocele of the Cord has been described by Pott and Scarpa; and, as a variety of hydrocele, has found its way into Surgical works. If it ever occurs, it is, probably, simply an œdema of the cord, and not any kind of cyst-formation.

Fig. 950.*

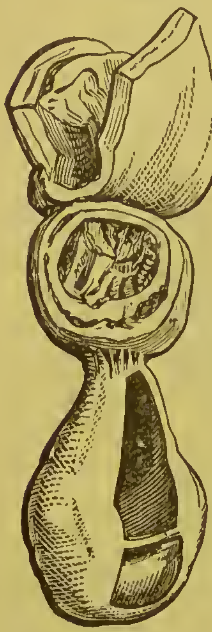
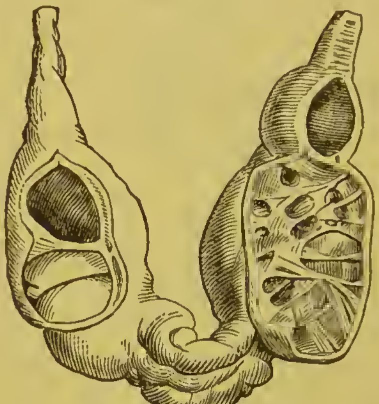


Fig. 951.†



Treatment would have to be conducted on ordinary principles; counter-irritation by blistering, or incision of any localized swelling to discharge the fluid and provoke consolidation.

Hydrocele of the spermatic cord may be associated with *inguinal hernia;* a complication which is well illustrated in the specimen here represented. (Fig. 950.)

Double hydrocele, one on either side, is sometimes met with; but more rarely, there may be also a coexisting hydrocele of either *spermatic cord*, as occurred in the case from which the parts are figured. (Fig. 951.)

Tumours of the Spermatic Cord may be noticed as rare pathological specimens, but which are seldom met with in practice. Thus, in one case, the cord was the seat of a medullary cancer (Fig. 952); in another case, a fatty tumour was found in the cord (Roy. Coll. Surg. Mus., 2461).

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* London Hosp. Mus., A. *g*. 47.

† Roy. Coll. Surg. Mus., 2339. Double hydrocele of the tunica vaginalis, with hydrocele of each spermatic cord; on one side the tunica vaginalis, on its inner surface, is adherent by films of plastic lymph, resulting from injection for the radical cure of hydrocele. Some of the injected fluid escaped into the cellular tissue of the scrotum; and the consequent inflammation was so severe, that the patient—an old man—died. (Liston.)

Hæmatocele.—By hæmatocele is meant an effusion of blood into the *tunica vaginalis;* or in a cyst connected with the testicle or cord—*encysted* hæmatocele.

The enclosed blood varies in quantity and condition. In the latter respect, the blood may be a sanguineo-serous fluid, or pure blood. It may be clotted, mingled with fluid, or become uniformly coagulated and laminated in layers, as in an aneurismal sac. Or, the coagula have undergone various states of decolourization and disintegration. The containing tunic or cyst usually becomes thickened, perhaps to a considerable extent, amounting even to an inch in thickness, and involving the surrounding cellular texture; as the result of inflammation induced by the presence of effused blood. In hæmatocele of the tunica vaginalis (Fig 953), this thickening involves also the tunica albuginea, but not the substance of the testicle, which remains healthy; although atrophied from constant pressure by the distended sac, or by the contraction of its own thickened tunic. Lymph is sometimes effused as a product of inflammation, on the inner surface of the tunica vaginalis, there being mingled with the blood.

Fig. 952.*

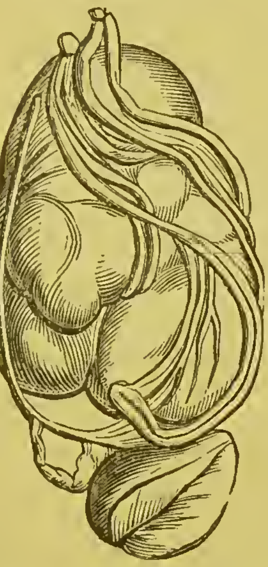
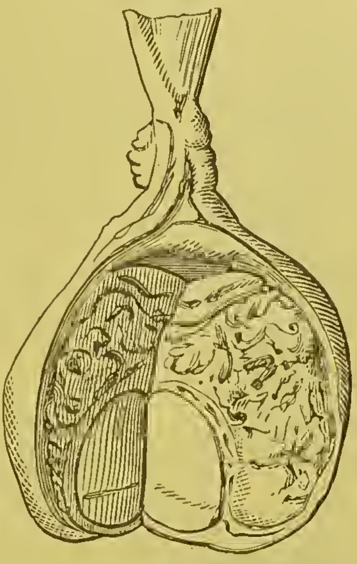


Fig. 953.†



The *cause* of Hæmatocele is *traumatic;* a blow or squeeze of the testicle; a strain, as affecting the cord; or other mode of violence. In hæmatocele of the tunica vaginalis, the source of the blood is some ruptured vein in the tunic, or a small rent in this membrane, or it may be

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[*] Roy. Coll. Surg. Mus., 2463. Medullary tumour of the spermatic cord; lobulated, of an ovoid form, and nearly six inches long. The substance of this mass had the usual soft and highly vascular character of encephaloid cancer; and the section (on the other side, not seen) shows a locular fibrous matrix, with contained cancer-substance. The vessels of the spermatic cord are spread out over the tumour. The testicle below is healthy. (Sir A. Cooper.)

[†] St. Thomas's Hosp. Mus., EE. 84. Hæmatocele of the tunica vaginalis, which is distended with fibrinous coagulum; the sac is enlarged, thickened, and indurated, in some parts having a cartilaginous appearance. The testicle is situated at the lower and posterior part of the tumour, and apparently healthy.

a wound of a vessel in tapping hydrocele. *Spontaneous* hæmatocele is also said to occur, apparently from rupture of an enlarged spermatic vein.

In hæmatocele of the cord, rupture of an enlarged spermatic vein is the source of effusion.

Hæmatocele of the Tunica Vaginalis.—An effusion of blood into the tunica vaginalis may occur as an original affection, or supervene upon hydrocele.

Signs.—In both cases a swelling is presented, which slowly and gradually increases in size, until it attains to that of a duck's egg or a cocoa-nut, or even to that of a melon. The swelling is more or less fluctuating and opaque. Sometimes ecchymosis of the scrotum is produced, whereby the tumour has a characteristic dark-coloured or black appearance, which, however, gradually disappears.

Diagnosis.—When the hæmatocele is a primary affection, its sudden appearance is distinctive, especially when the swelling is known to have immediately followed a blow, and is not the product of inflammation. When a hydrocele suddenly enlarges and loses its transparency, an effusion of blood has probably taken place. Ecchymosis of the scrotum, in either case, will confirm the diagnosis. *Chronic* hæmatocele, and without any ecchymosis, may be mistaken for other tumours in the scrotum. The diagnosis must then be determined by the distinctness of fluctuation, the rate of increase of the swelling, and its cause. *Cancer* of the testicle is apt to be mistaken for hæmatocele; in numerous instances, malignant testis has been opened for hæmatocele; and the more serious error has been committed of removing an hæmatocele for malignant disease. The most constant distinction is the steadily increasing growth of cancer; whereas hæmatocele sometimes ceases to enlarge, or even diminishes in size. Puncture of the tumour should always be resorted to as the turning-point of diagnosis, before proceeding to remove the testicle.

Treatment.—In *recent* hæmatocele, and where the blood yet remains fluid, absorption may, perhaps, be induced; by rest, cold lotions, or leeches, according to the inflammatory state of this affection. Even when hæmatocele supervenes on hydrocele, this treatment has proved effectual, without any operative interference.

In more *advanced* and chronic hæmatocele, the state of the blood, as being fluid or solidified, will mainly indicate the requisite operative procedure. *Fluid* blood can be evacuated by tapping; and with iodine injection a radical cure may be effected, as in hydrocele. The admixture of a proportion of blood with serous fluid, will probably not frustrate this method of cure. In hæmatocele, as in hydrocele, the variable position of the testicle should be remembered in puncturing the tunica vaginalis. Commonly situated at the back of the sac, the testis was found in front, and was wounded, in two cases recorded by Mr. Curling. *Solidified*, or firmly coagulated blood, cannot be evacuated by puncture; it will then become necessary to make a free incision so as to lay the tunica vaginalis entirely open, to turn out the clots, and wash it out thoroughly by syringing. Otherwise, any remnant blood undergoing decomposition in the sac, sloughing and systemic infection are liable to result. Profuse hæmorrhage has, however, been known to follow free incision; a source of danger which cannot be avoided.

When the hæmatocele has attained a very large size, and the tunica vaginalis has become much thickened, castration, in order to remove the entire mass with the testicle, may be the safest procedure. This will be especially advisable in elderly persons.

Encysted Hæmatocele of the *Testis*, or of the *Cord.*—Cysts, containing blood, are occasionally met with; both in connection with the testis and the spermatic cord.

In connection with the *Testis* (Fig. 954), it may be difficult or impossible to distinguish encysted hæmatocele from ordinary hæmatocele of the tunica vaginalis. Hæmatocele of the *Cord*, arising from a strain or other violent exertion, presents a cystic swelling in some portion of the spermatic cord; but it is always distinct from the testicle or the tunica vaginalis. (Fig. 955.) Commencing usually within the inguinal canal, the tumour has a round or oblong shape; and, increasing in size, it extends downwards through the external ring into the scrotum, where it may attain an enormous size. In one remarkable case related by Bowman, the tumour, after existing for ten years, had reached down to the patella, and was so heavy as to require both hands and a considerable effort to raise it from its bed. The swelling is semi-elastic, but opaque, when of sufficient size to be examined by transmitted light. As in hydrocele of the cord, hæmatocele of the cord is movable, unaffected by compression, and receives no impulse on coughing. These characters distinguish it from hernia, unless when situated within the inguinal canal, where the diagnosis is often most difficult.

Fig. 954.*

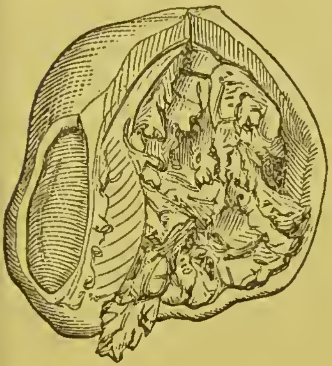
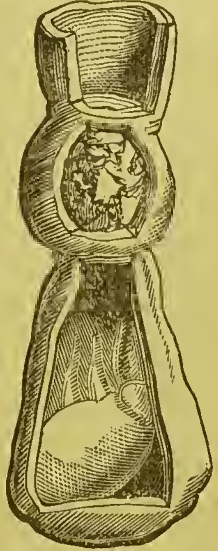


Fig. 955.†



Treatment.—In the *recent* condition of Encysted Hæmatocele,—the blood remaining as yet fluid,—remedial measures may be directed to promote absorption, by rest and evaporating lotions. An incision, in this state of the hæmatocele, might lead to fearful hæmorrhage from the ruptured vein.

In an *advanced* condition, the mode of treatment must vary according to the fluid or solidified state of the blood. Tapping, or coupled with iodine injection, will now become appropriate; or an incision, to turn out the coagula, in order that the cyst may granulate and heal from the bottom.

Varicocele.—An enlarged and varicose condition of the spermatic veins, known as Varicocele or Cirsocele, is attended with certain marked characters.

Signs.—A swelling, of an ovoid or pyramidal shape, with its base downwards, forms between the testicle and external abdominal ring;

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* Roy. Coll. Surg. Mus., 2460a. Encysted hæmatocele; showing the interior of a cyst, filled with fibrinous coagulum, and the adjoining tunica vaginalis, open. (R. Quain.)

† Ibid., 2460. Hæmatocele of the spermatic cord; with hydrocele of the tunica vaginalis, below; and the sac of an inguinal hernia above the hæmatocele. (Hunterian.)

usually on the left side of the scrotum. This swelling feels knobbed and convoluted; slipping about between the fingers as if it were a *bundle of worms.* It is inelastic and compressible, but the swelling gives a slight impulse on coughing, and it slowly diminishes in the recumbent posture, reappearing in the erect position and increasing after long standing, although moderate pressure be maintained on the external ring. The enlarged veins may often be seen through the thin scrotal skin. There is little or no pain, but a sense of tension and weight, which is at once relieved when the patient lies down. Sometimes the swelling becomes temporarily painful, the pain assuming even a neuralgic character, apparently from compression of some branch of nerve, when the varicocele is recent, and rapidly formed, although without having attained to any notable size. The testicle becomes more or less atrophied, and, when much reduced in size, it may be almost concealed beneath a large varicocele. Double varicocele sometimes occurs, but that on the left side is even then the most developed.

The *diagnosis* of varicocele from scrotal hernia may be readily determined by the peculiar feel of the swelling; although both the tumours have some resemblance, in being affected by coughing and by posture. From hydrocele of the tunica vaginalis, or of the cord, varicocele differs in virtue of all these characters; and as regards the former hydrocelic affection, varicocele has the additional distinction that it does not extend down to the testicle so as to envelop this organ.

The *causes* of varicocele are both predisposing and exciting. *Predisposition* consists in the anatomical constitution of the spermatic veins —their size and tortuosity near the testicle, their numerous anastomoses and long efferent trunks, favouring the accumulation of blood, and the loose cellular texture of the scrotum affording little support; while the veins are frequently subjected to pressure by the action of the abdominal muscles. The specially predisposing circumstances usually assigned for the far more common occurrence of varicocele on the left side are—the greater length of the left spermatic vein, which opens into the renal, while the right joins the vena cava; and owing also to the slightly lower position of the left testicle; the rectangular junction of the left spermatic vein with the renal; and its relation to the sigmoid flexure of the colon as a source of compression. In respect to age, varicocele commences usually at about eighteen or twenty, very rarely before puberty, although I have seen one case; and when commencing after thirty or thirty-five, it is generally the result of injury or continued pressure on the cord. As age advances, the enlarged veins evince a tendency to diminution. Varicocele is found in about one male adult in ten, according to Dr. Humphry's observations. The *exciting* cause may be any exertion which tells upon the spermatic veins, as straining at stool, long walking exercise, standing or riding. Any such exertion, having induced varicocele, will also aggravate it from time to time.

Treatment.—The necessity for any interference with varicocele should be determined by various circumstances: an increasing size of the swelling, the inconvenience or pain occasioned by it; the tendency to atrophy of the testis, and sometimes to spermatorrhœa; with the mental depression induced by this state, or resulting from prolonged anxiety respecting the supposed loss of generative power. These circumstances will also indicate the propriety of palliative measures, or of having recourse to the radical cure by obliterating the affected veins.

Palliative treatment consists in wearing a scrotal suspensory bandage or an elastic bag, to support and slightly compress the enlarged veins; or a well-adjusted truss, with the pad upon the external ring, to prevent any sudden reflux of blood into the veins during exertion. The latter appliance has proved an effectual cure in some instances, which Mr. Curling mentions, after the truss had been worn some months, and in which the testicle, partially atrophied before the treatment began, regained its natural size. But the contrary result may be produced, as in a case related by Pott, where the testicle had shrunk to nothing, while the veins had become enormously enlarged. Certain means have also been tried in accordance with the principle of scrotal support, by lessening the *size* of the bag. This has been done by drawing a portion of the scrotum through a soft metallic ring covered with wash-leather, or a vulcanized indiarubber ring; a method of treatment originally suggested by Mr. Wormald. Or a portion of the scrotum has been excised with the same object in view; but this plan is too uncertain, as to its efficacy, to justify its severity as a palliative measure.

During any occasional period of pain or tenderness in the affected veins, the recumbent posture and rest, a cold evaporating lotion, and saline aperients will give relief.

Curative treatment.—Obliteration of the enlarged and varicose veins has been attempted by various operative procedures: by compression with forceps fixed on the scrotum,—Breschet's method, now, I believe, abandoned as useless; subcutaneous ligature; subcutaneous compression between a pin and wire rolled round it; compression by hare-lip pins and twisted suture, with or without intermediate subcutaneous section of the veins.

The modes of operation most frequently practised are—subcutaneous ligature, as proposed by Ricord; and compression at two points, with intermediate subcutaneous division, as proposed by Mr. H. Lee.

(1.) Ricord's *subcutaneous ligature* is thus described by Mr. Curling:—The vas deferens being separated from the mass of veins, and the latter being pinched up with a fold of the scrotum, a needle set in a handle, with an eye near the point, armed with a double-looped thread, is to be passed beneath them. When the needle has traversed from one side to the other, the loop is to be drawn out, the needle retracted, and the veins let go, the skin alone being now held up. A second needle, similarly armed, is then to be passed through, over the veins, entering at the same aperture by which the first needle was thrust out, and emerging at the same aperture by which it entered. The second loop is next to be drawn out, and the needle withdrawn. The bundle of veins is thus included between two threads, one passing over and the other beneath it. The ends of the thread on each side are then to be passed into the loop of the other, and by drawing these ends in opposite directions, the veins are tied beneath the skin. The vessels become divided, and the ligatures separate from the tenth to the twentieth day.

A *simple* mode of subcutaneous ligature is that performed by Mr.

Erichsen. Having separated the vas deferens from the veins, a small incision is made, about half an inch long, in the front and back of the scrotum; then a needle, armed with silver wire, is passed between the vas and the veins, so as to be brought out behind, and the needle returned in front of the veins; thus these vessels are included in a loop of wire, without implicating the scrotum. The loop is then tightly twisted, whereby the enclosed veins are constricted. By repeated tightenings, the wire gradually effects a passage by ulceration through the veins, which are obliterated by the same process. Or, Mr. John Wood's *spring-tractor* may be used for constricting the veins.

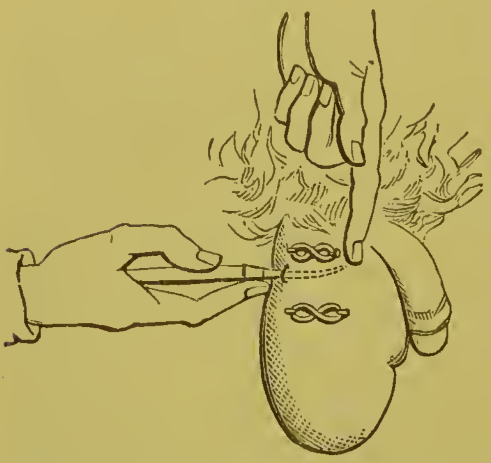
(2.) *Subcutaneous twisting* and *compression* of the spermatic veins.—Vidal de Cassis' method consists in passing an iron pin between the vas deferens and the veins, thus transfixing a portion of the scrotum, as in the previous methods of operation; but the pin is provided with an aperture at either end, and now a needle, carrying a silver wire, is passed in at the point of entrance of the pin, and over the veins, emerging at the other puncture; then, either end of the wire is threaded through the corresponding aperture of the pin, and this rod is twisted round and round, whereby the wire is coiled, and the veins also rolled up and firmly compressed in the loop between the pin and the wire.

Two needles may be used in this method; the one taking the place of the wire, being made to twist round the other.

(3). *Compression by two Pins, and intermediate subcutaneous division of the Veins.*—This mode of obliterating the spermatic veins is the same as that for varicose veins in the leg—according to Lee's method. The operation is performed in precisely the same way (Fig. 956); care being taken to exclude the vas deferens, which is easily recognized by its round, firm, whipcord character. One or more pins were used for compression, *without* subcutaneous division of the veins, in Davat's method of operation; and as since practised by Velpeau, Jobert, Liston, Fergusson, and some other Surgeons.

These operative procedures have been variable in their *results.* Great relief or a cure has been effected in several instances; and I have been accustomed to practise the last-named operation, by the former method, with a fair proportion of success. On the other hand, no good has been produced, the operation proving abortive; or only a temporary cure has resulted, the varicocele returning at no distant period. Diffuse inflammation and sloughing of the scrotum, and even suppuration of the testicle, or phlebitis, pyæmia, and death, have been known to follow the operation. Pyæmic infection is, I believe, more likely to happen, when the veins are subjected to ligature, twist, or compression, at a single point; but when applied at two points, the intermediate portion of the veins is shut off, and thus excluded from any commu-

Fig. 956.



nication with the blood in circulation. Atrophy of the testis may be mentioned as an occasional result; but this will probably be avoided by not cutting off the supply of blood entirely, in any procedure for obliterating the enlarged veins. The whole of the veins should not be included in the ligature, or subjected to compression and division; and the spermatic artery should be excluded, a precaution easily observed by keeping free of the vas deferens, near which the artery lies.

INFLAMMATION OF THE TESTICLE.—This subject comprises *Orchitis*, when the testicle itself is the seat of inflammation; and *Epididymitis*, when the epididymis is primarily affected. *Chronic* enlargement of the testis or of the epididymis, resulting from special causes of inflammation, may be Syphilitic or Scrofulous. These affections will be afterwards considered.

ORCHITIS and EPIDIDYMITIS.—Inflammation of the Testis occurs less frequently than that of the Epididymis. But either part being primarily affected, the other becomes involved; and thus Orchitis and Epididymitis are usually found associated.

Symptoms.—Swelling arises, which has the characteristic shape of the part wherein the inflammation is seated; whether the testis, presenting an ovoid swelling; or the epididymis, when its inferior globus presents a nodular enlargement; or the whole of the epididymis, in the form of an elongated mass at the back of the organ, can be readily distinguished. As the swelling rapidly increases, it soon becomes tense and hard, especially in the testis, owing to the resistance of its more unyielding tunic; and it attains to a considerable size, that of an orange or even a small cocoa-nut. Effusion often takes place into the cavity of the tunica vaginalis, as well as into the substance of the gland, of the epididymis, or of both these structures; and thus the swelling may be exaggerated beyond what really pertains to the testicle. Pain accompanies the swelling, and it increases in severity proportionately to the tension of the part; with a sense of dragging weight, or a dull, heavy, aching, and sickening pain, extending up the cord into the groin, iliac region, and loins. The scrotum becomes tender, distended, and reddened, exhibiting also a congested state of the scrotal veins; as the integument and subcellular texture participate in the inflammation. Sharp inflammatory fever attends the development of the disease; and there is usually considerable nausea, or even vomiting and constipation, simulating strangulated hernia.

Causes.—Various *injuries* of the testicle, and sources of *urethral irritation*, may give rise to orchitis or epididymitis; and certain constitutional diseases have a predisposing influence, or may directly induce these inflammatory affections. Thus, exciting causes comprise: a blow, squeeze, or wound of the organ; urethral irritation, especially near the orifices of the seminal ducts, as by gonorrhœal or other inflammation of the urethra, stricture, or the introduction of instruments, the impaction in, or the passage through, the urethra of a calculus; injury to the vas deferens in lithotomy or in puncture of the bladder per rectum. The various sources of irritation in the urethra, or occasions of injury to the seminal ducts, more commonly give rise to epididymitis than to orchitis; although the testis often becomes secondarily inflamed.

The causative *operation* of urethral irritation in exciting inflammation of the epididymis is doubtful. It does not arise from gonorrhœa until the urethral inflammation is subsiding, and when perhaps discharge alone remains. Some slight external cause of irritation, such as active walking exercise, riding on horseback, or the friction of tight trousers, may then produce epididymitis. Sudden suppression of the urethral discharge seems to give rise to this inflammation, by *metastasis* or transference; or, the discharge continuing, it would appear that the morbid action *extends* along the vas deferens from the urethra to the testicle. Sometimes, indeed, the cord in the inguinal canal presents a hard and tender swelling, continuous with that of the epididymis in the scrotum. Orchitis or epididymitis consequent on gonorrhœa has also been termed a *sympathetic* inflammation—a very indefinite term.

Of *constitutional* causes, mumps more frequently affects the testis than the epididymis, but the inflammation may commence in either part and extend to the other; syphilis, scrofula, gout, and rheumatism, especially gonorrhœal rheumatism, may also severally predispose to, or induce, inflammation either of the testis or of the epididymis. Excepting however syphilis, which chiefly affects the testis, the scrofulous, gouty, and rheumatic diatheses generally induce epididymitis, the testis becoming secondarily affected. Children are liable to acute orchitis, but inflammation of the epididymis is more common at an early age.

Terminations.—Acute inflammation of the testicle or of the epididymis usually subsides by *resolution*, in a period varying from a week to a fortnight or longer. As the disease declines, the distinctive characters presented by the enlargement of the two constituents of the organ again become apparent. The testis first resumes its natural size and shape; the epididymis often continuing enlarged, irregular, and hardened, for a considerable period. Ultimately, when the structural condition of the organ is restored, its functional power remains unimpaired. *Atrophy* is sometimes the result of inflammation; exceptional cases of this kind, in consequence of mumps, have been seen by Dr. Hamilton, M. Rilliet, and Professor Humphry. *Suppuration* rarely occurs, though I have seen it in one case.

Treatment.—In the *acute* stage.—Local blood-letting is a most effectual means of subduing the inflammation, whether as orchitis or epididymitis. Blood may be abstracted by the application of leeches to the scrotum, or by puncturing the congested scrotal veins. The latter method is preferable, as leech-bites are apt to become centres of inflammation. Puncturing is most conveniently commenced at the lower part of the scrotum, so that the blood trickling from the veins first opened, shall not obscure the vessels above. Warm fomentations should then be applied, whereby double the quantity of blood may be drawn off than would otherwise be procured. Six or eight ounces of blood having been taken in this way, rest in the recumbent position, with the scrotum well supported by a pillow or handkerchief, will complete the local treatment in the acute stage of inflammation. It has been proposed to puncture the *tunica albuginea* at different points, in order to reduce the tension resulting from this fibrous tunic; and I have heard that great relief, and even a cure, has been thus speedily obtained, in several instances. I have had no experience of this resource; but it would seem to be at least unnecessary, seeing that the inflammation is amenable to ordinary antiphlogistic measures. *Consti-*

tutional treatment consists in the administration of antimonial saline aperients, combined with opium, hyoscyamus, or other sedatives. When, indeed, the inflammation follows gonorrhœa, hyoscyamus in full doses, with camphor mixture, will, I have found, often prove sufficient to subdue the pain and swelling; unaided by any other medicinal agents. This method of treatment was, I believe, originally proposed by Mr. Gay.

Pressure, as by means of strapping the testicle, has been highly recommended, in the acute stage, by Fricke, of Hamburg; but at this period it generally increases the inflammation, or at least intolerably aggravates the pain.

Chronic enlargement, resulting from acute inflammation, is best reduced by strapping. Simple adhesive plaster may be used, or the emplastrum ammoniaci cum hydrargyro and soap-plaster, as affording both pressure and a stimulant application.

Strapping a testicle is a simple proceeding, but requires to be done so as to give uniform support. Several strips of plaster must be provided, each about an inch broad, and of sufficient lengths to embrace the enlarged testicle, vertically and horizontally. The scrotum having been shaved, it should be drawn well upwards on the side of the enlargement. Then, a long strip of plaster is passed from under the scrotum above the enlarged testicle, and brought round the corresponding side of the scrotum, so as to isolate the testis from the opposite side. Strips are then passed in succession, longitudinally and horizontally, each strip overlapping the next, and drawn moderately tight; thus uniformly enveloping and moderately compressing the whole organ. Care should be observed not to strangle the scrotum above, as sloughing has been known to occur.

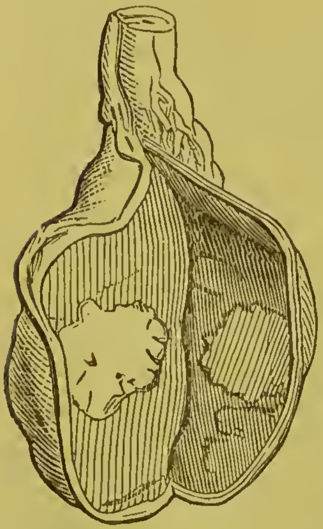
Chronic Enlargement of the Testicle, or *Sarcocele.*—This condition of the Testicle may be the result of *simple* inflammation, having a traumatic origin; or it may be a manifestation of certain *constitutional* diseases—Syphilis or Scrofula. Thence, three varieties of Sarcocele may be recognized, in regard to their *origin.* But the attempt to carry their distinction further has failed to establish any *essential* points of pathological difference;—in respect to the structural condition of the chronic enlargement, its signs or external characters with regard to diagnosis, and its terminations. The peculiar treatment requisite will, of course, depend upon the origin or cause of the Sarcocele.

Syphilitic Sarcocele.—In this variety of chronic enlargement of the testicle, the gland itself is chiefly affected, and less frequently the epididymis. It consists of a fibrinous deposit, in the form of nodules, situated in the *interstitial connective tissue* of the glandular structure, in the septa, mediastinum, and tunica albuginea; and sometimes extending into the connective tissue of the epididymis. Thence, the organ becomes considerably enlarged, to the size of a turkey's egg, or perhaps of a cocoa-nut; it has an ovoid shape, is heavy, hard, and *nodulated.* But, when the deposit is principally central, the organ may be smooth externally. An effusion of fluid sometimes takes place into the tunica vaginalis, constituting hydro-sarcocele; a condition which masks the enlargement of the testicle, until the fluid is evacuated. There is little or no pain, only the inconvenience of the dragging weight. One, or not unfrequently both testicles, may be affected; though not in an equal degree, and more often in succession. The diagnosis, however, must be determined by the syphilitic history.

The *consequences* of this enlargement are atrophy of the glandular structure, owing apparently to contraction of the intestinal fibrinous deposit; as in cirrhosis of the liver. Nevertheless, the tubuli seminiferi sometimes become involved; their walls being thickened and blended with the intervening tissue, according to Virchow, while the epithelium lining them undergoes pigmental and fatty degneration. The function of the organ will be proportionately and permanently impaired or destroyed. This tendency is particularly noticed by Vidal (de Cassis), who, however, gives instances of recovery of function in testicles which had been severely invaded by syphilitic orchitis. Suppuration may take place, as a consequence of the chronic enlargement; forming an abscess in the substance of the testicle. The pus may degenerate into a caseous, calcareous, or earthy mass; but usually the abscess, increasing, at length contracts adhesion with the tunica vaginalis and scrotal integument, and then bursts through the tunica albuginea and discharges externally. The aperture having continued for a time, closes permanently; or a succession of abscesses form, burst, and heal. Any such abscess of the testicle, having burst, is not unfrequently followed by ulcerative enlargement of the aperture, and protrusion of a portion or whole of the organ,—forming hernia testis. (See Fig. 959.) The integument, thickened and indurated, constricts the protruded portion; and granulations springing up, give an expanded appearance to the protrusion, beyond what is really testicular.

Treatment.—When syphilitic sarcocele has not been long established, absorption of the deposit may be somewhat promoted by means of medicinal agents; without injuriously affecting the general health, or damaging the remaining tissue of the organ. A mercurial course, combined with tonics, often proves beneficial; the bichloride of mercury, in doses of the twelfth or eighth of a grain, with quinine, three times a day, and continued for six or eight weeks. Iodide of potassium may then be advantageously substituted, until the hardness and swelling disappear. *Strapping* the testicle, as already explained, with adhesive or mercurial plaster, is less effectual in promoting absorption; and sometimes it seems to arouse the inert deposit to suppuration.

FIG. 957.*



Scrofulous Sarcocele.—This variety of chronic enlargement of the testicle differs only from that of syphilitic origin, in two particulars: generally the epididymis, and even the vas deferens,—sometimes, however, the testis,—is primarily the seat of scrofulous deposit (Fig. 957); and this is at first contained *within* the tubules. The *nodular* form of enlargement is usually presented; and as the testicle itself soon becomes implicated, the whole organ is enlarged and irregular, at an early period of the disease. Tubercular deposit, in the form of grey, semi-transparent, granular tubercles—as found in the lungs—may represent the kind of deposit in the enlarged testicle; thence named *tuberculous* sarcocele. (Fig. 958.) Hydrocele sometimes ensues, disguising the testicular enlargement, until the fluid is evacuated. Generally one testicle only is affected, though both may be involved.

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* London Hosp. Mus., E. *f.* 61. Testicle laid open; showing a central deposit of pale, firm, scrofulous matter, consisting of fibro-corpuscular lymph,—"Chronic scrofulous orchitis." (Andrew Clark.)

The almost painless character of the disease, as in syphilitic sarcocele, reduces the diagnosis of these two varieties of sarcocele to the external characters of the enlarged testis; and as these are not positively distinctive, the nature of the disease can only be determined by the coexistence of other scrofulous affections or tendencies. Thus, the condition of the lungs should be examined, and that of the prostate and seminal vesicles; the latter parts being not unfrequently also enlarged by scrofulous deposit.

The *consequences* of scrofulous sarcocele are not peculiar; but the tendency to suppuration and abscess, followed by hernia testis, is even more marked than in syphilitic sarcocele. There is also abscess in the epididymis, extending up the vas deferens, and converting their hardened enlargement into a fluctuating bag of pus.

FIG. 958.*

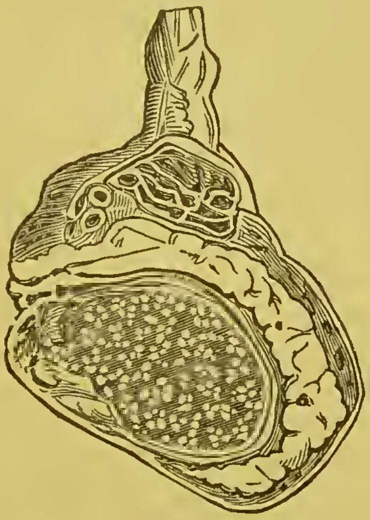
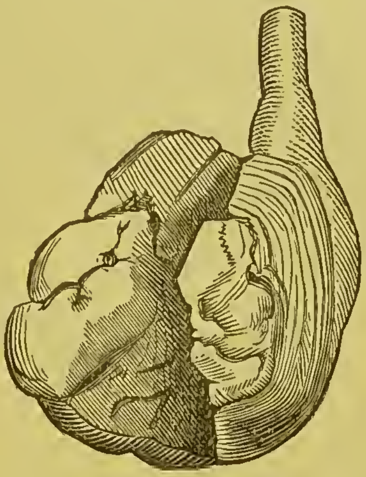


FIG. 959.†



Treatment.—Constitutional and hygienic measures are more likely to prove beneficial than any local treatment. Tonics, principally iron or the iodide of iron and quinine, with cod-liver oil, should be taken for a considerable period; the diet must be well regulated, and other means adopted for the improvement of the general health. At the same time, the iodide of lead ointment, and strapping the testicle, may have some locally curative influence of subordinate importance.

Abscess in the Testicle, as the result of inflammation of this organ, occurs sometimes from syphilitic orchitis, but more commonly from scrofulous orchitis. The *signs* of this condition are in no way peculiar, and the *treatment* must be conducted on ordinary principles.

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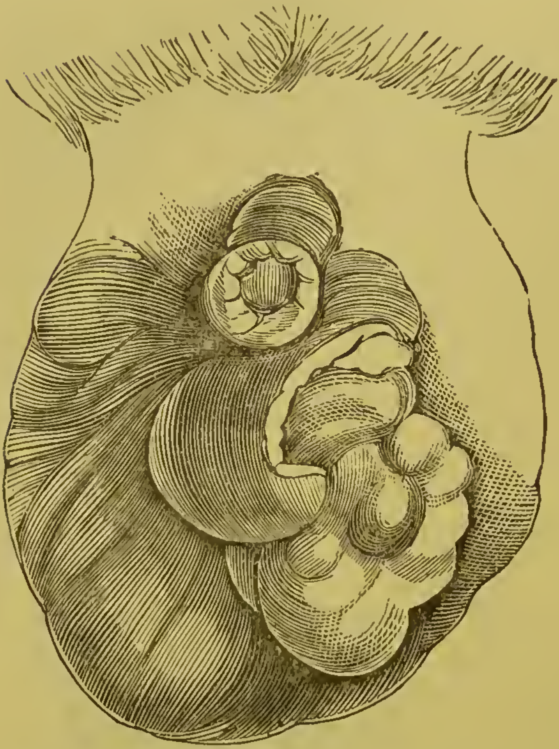
* London Hosp. Mus., E. *f.* 85. Section of a testicle much enlarged; showing isolated tubercles in the body of the gland. Some of them have coalesced into little masses. The epididymis is full of caseous tubercular deposit, some of which is puriform.

† Roy. Coll. Surg. Mus., 2383. Scrofulous testis, with fungoid protrusion; seen also in section.

Hernia Testis, or protrusion of the testicle, is apt to follow the bursting of an abscess. The appearances have been already noticed. It presents, usually, a red, granular, fungous mass (Fig. 959), but varying according to the state of inflammation, sloughing, or granulation. The mass becomes expanded over, and is constricted by, the margin of the aperture in the conjoined tunica albuginea, tunica vaginalis, and indurated scrotal integument. (Fig. 960.)

FIG. 960.*



Treatment. — According to the *size* of the protrusion, the attempt may be made to repress it, or it will be necessary to remove the mass. When of small size, a cure may often be effected by pressure; some lint or charpie spread with the ointment of red oxide of mercury is laid upon the protrusion, and well strapped down with strips of plaster. Or, the integument may be detached on either side of the protrusion, the edges pared, and brought over it in front, and retained by suture; pressure being thus applied, as suggested by Mr. Syme. Another plan, devised by Dr. Pagan, of Glasgow, consists in dissecting down to the tunica albuginea, and then incising the margin of the aperture in that tunic, like the ring in strangulated hernia. After this, the treatment is said to be much more successful.

When either of these plans has failed, or the protrusion is of larger size, it should be removed by shaving it off with a bistoury. During the process of granulation, the tendency to exuberance and reprotrusion should be repressed by dressing with the mercurial ointment, and strapping.

If nearly the whole organ be protruded, or the portion left by excision be found diseased, it will be better to have recourse to castration. The remnant portion of testicle would be of no functional use, and would slough away, prolonging the cure.

TUMOURS.—The testicle, like other organs, is liable to be the seat of various morbid growths, forming Tumours; all of which are distinct in their nature from Chronic Enlargement or Sarcocele, as resulting from any kind of morbid deposit,—Syphilitic, Scrofulous, or Tuberculous.

Tumours of the Testicle, thus pathologically distinguished, may be Cystic; occasionally, Cartilaginous and Fibrous; or Cancer,—Encephaloid and Scirrhus. These various testicular Tumours are sometimes described as additional forms of Sarcocele, a misleading designation respecting their real nature.

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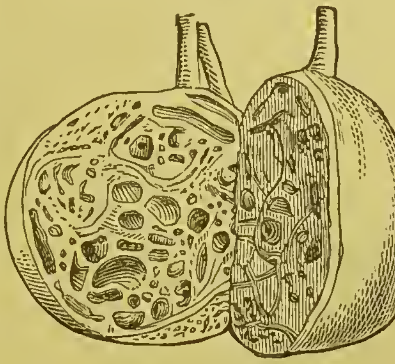
* Royal Free Hospital. (Author.)

Cystic Tumour of the Testicle.—This form of Tumour, known also as the Hydatid Testis of Sir A. Cooper, may be purely Cystic; or associated with Cartilaginous or with Cancer Growth.

Cystic Disease consists of an agglomeration of cysts, thin-walled, varying in size from a pin's head to a walnut, and their globular shape modified by mutual pressure. (Fig. 961.) They are *simple* cysts; containing fluid, thin and colourless, or viscid and blood-tinged or otherwise discoloured; or they become *proliferous*, bearing on their interior fibrous growths, of a pedunculated and lobulated shape, which occupy and eventually distend the cysts. These intra-cystic growths have been found by Mr. Quekett to possess a cellular structure covered on the surface with cylindrical epithelium, and they may contain small, hard, spherical bodies like pearls, composed of concentric layers of condensed epithelium. Fibrous tissue, in variable quantity, is formed with, and intervenes between, the cysts. When constituting the chief element of the tumour, this has been named *fibro-cystic* tumour. Thus Paget describes the cystic growth as essentially a fibrous, or fibrous and cartilaginous, tumour in the testicle, with more or less cyst-formation in its substance.

Fig. 961.*



The growth is not generally diffused throughout the organ,—it originates, and remains circumscribed, in one part; and as the growth increases, the unaffected portion of the testicle is pressed aside or spread out over the tumour; so that the mass, which is usually spherical, can perhaps be shelled out, leaving a considerable part of the testicle healthy. Occasionally, gland tissue has been found dispersed to a certain amount through the cystic tumour. The epididymis, at first unaffected, becomes flattened, compressed, and atrophied; while the surfaces of the tunica vaginalis becoming perhaps adherent, the cavity is more or less entirely obliterated.

The primary situation, and mode of origin, of the cysts are doubtful. They appear to originate in the substance of the organ; but whether in the tubular gland tissue, or in the connective tissue, is uncertain. And the mode of cyst origin may perhaps be a dilatation of the seminal tubules, as Sir A. Cooper originally stated, and Mr. Curling seems to have confirmed; or the cysts may originate as independent formations. Respecting the probability of the former mode of production, it is a remarkable fact that spermatozoa are never found in the cysts. Hydrocele seldom coexists with cystic testicle. One organ only is affected with this disease.

Signs and *Diagnosis.*—The testicle enlarges, acquires an oval or nearly spherical form, and slowly attains to a considerable size. Its weight is less than that of any solid tumour, but it is heavier than hydrocele. Elasticity, over a limited area, with less decided fluctuation, and a total absence of transparency, will chiefly distinguish cystic testicle from hydrocele. The painless character of the tumour, and absence of constitutional symptoms, with the slow rate of growth, may determine the diagnosis with regard to encephaloid cancer of the testicle. But the distinction between cystic-growth and non-transparent hydrocele, hæmatocele, and cancer, cannot sometimes be arrived at with certainty, except by the aid of puncture to examine the nature of the fluid yielded, and at several points of the tumour. Cystic testicle is most frequent between twenty and fifty.

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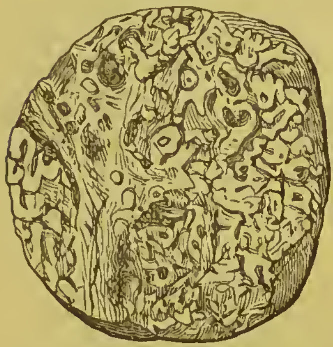
* Roy. Coll. Surg. Mus., 2388A. Cystic tumour of the testicle. (E. Cock.)

No particular *cause* can be assigned for the production of this disease, otherwise than it seems occasionally to be consequent on injury to the testicle, as a blow or squeeze.

Treatment.—Castration is the only cure; and it may be resorted to at an early period, especially when the other testicle is healthy and functionally efficient. As in the case of other double organs, the remaining testicle will probably acquire the power of doing double duty. The disease never returns, a therapeutically important distinction as compared with Cancer.

Fig. 962.*



Cartilaginous Growth, or Enchondroma, is often associated with Cystic Tumour. The cartilage usually exists in the form of nodules (Fig. 962), set in a fibrous matrix, or which grow from and occupy the interior of the cysts; as a cartilaginous variety of proliferous cysts. These nodules are sometimes strung together into lines; as if the cysts had formed by sacculated dilatations of the seminal tubes of the testis or its rete, in accordance with Curling's interpretation of cystic testicle. The cartilaginous structure may undergo calcification or ossification.

This structural admixture of cartilage, or of its transformation, with cysts, modifies the *signs* of cystic tumour of the testicle, by giving hardness and weight to the mass. But any such complication in no way contra-indicates the treatment by castration, nor affects the success of its result.

Cancer-Growth is not unfrequently associated with Cystic Tumour; this growth also taking place from the interior of the cysts, as a cancerous variety of proliferous cysts. The kind of cancer is encephaloid, and it forms in some parts of the tumour, leaving the remainder simply cystic; but ultimately perhaps invading the whole mass.

The *signs* of cystic testicle are modified accordingly; and although the treatment must still be castration, yet the result of the operation, as to a return of the disease, will be uncertain.

Hydatid cysts are said to have occurred in cases recorded by Sir A. Cooper, Dupuytren, and Larrey. But the accuracy of such cases may be doubted.

Dermoid cysts, of congenital origin, have unquestionably been met with in some instances; the cysts containing sebaceous matter, hair, teeth, and other fœtal constituents, located in the testis and scrotum.

The tumour presented by any of these abnormal cyst-formations will necessarily be of a doubtful character, even when examined by an exploratory puncture.

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* Roy. Coll. Surg. Mus., 2384. Enchondroma, or cartilaginous tumour of the testicle; section, showing projecting coral reef-like masses of cartilage, set in a fibrous matrix. A few cysts beset the tumour. (Sir A. Cooper.)

Castration reveals the nature of the case, while it affords the only remedy.

FIBROUS TUMOUR OF THE TESTICLE is generally enumerated among the Tumours to which this organ is liable. An apparently well-marked specimen is described by Cruveilhier. Its consistence was very firm, and it creaked under the scalpel; the weight of the tumour was heavy in comparison with its size, which was twice that of the natural size of the testicle. In point of structure, when examined, it was found to consist of contorted and interlaced greyish-white fibres, forming lobules, with vessels penetrating their interspaces; thus certainly confirming the nature of this tumour. Sir B. Brodie describes a less well-marked specimen, which he removed by castration. Sir James Paget speaks of a "fibro-cellular tumour," removed in like manner by Mr. John Lawrence; and which was so succulent that, in its consistence, it resembled a fatty tumour.

Signs.—The enlarged testicle has a uniform shape, and the tumour is very hard and heavy, painless, and of slow growth.

Castration is not followed by recurrence of the growth.

CARTILAGINOUS TUMOUR OF THE TESTICLE is sufficiently noticed in connection with Cystic Tumour. These two forms of growth are so very frequently associated in the same Tumour, that the pathology and treatment of Enchondroma of the Testicle, as an independent form of Tumour, need not be considered separately. Several well-marked specimens will be found in the Museum of the Royal College of Surgeons.

CANCER OF THE TESTICLE usually appears in the form of *encephaloid*, or occasionally its melanotic variety; rarely in the form of *scirrhus*. *Colloid* is said to have occurred; and *epithelial* cancer, having originated in the scrotum, has been known to invade the testicle, as an extension of the disease, though not to appear primarily in this organ.

Encephaloid cancer commences generally in the glandular portion, as small masses among the tubuli seminiferi; and these increasing, coalesce, to the destruction of the glandular substance. Less frequently, it begins at one point in the centre of the testis, or in the rete; occasionally, in the epididymis; and rarely, in the tunica vaginalis, as noticed, however, by Sir E. Home, Sir A. Cooper, and Mr. Curling. From either of these sources the growth invades the whole organ, reducing it to a cancerous mass, without any trace of the natural structure.

The encephaloid mass has, as usual in this species of cancer, a soft pulpy consistence, and commonly a more or less uniform white or pinkish-white colour. As the proportion of cancer-cells or of the containing filamentous areolar stroma predominates, so is the cancer substance developed (Fig. 963); or the mass assumes the characters of a fibrous tumour. Or the cancer tumour may be associated with cyst-formation, or with cartilaginous structure, in its substance. Thus, then, all the forms of morbid growth to which the testicle is liable, may be associated in one and the same Tumour. Hæmorrhage is apt to occur in the substance of Encephaloid Testicle, from any slight blow or external injury; and the blood may be effused interstitially, or into irregular cavities produced by its pressure. As the cancerous testicle increases with a tolerably steady, but on the whole rapid, progress, it attains to a large size; the tunica albuginea yielding under pressure to a very great extent without rupture. At length it bursts, and the mass protrudes as a bleeding fungus through the ulcerated skin. (Fig. 964.) The disease extends along the cord to the abdomen, and the lumbar glands become involved; secondary cancer also being developed in other organs. Death ensues; usually, in about eighteen months or two years.

Fig. 963 *

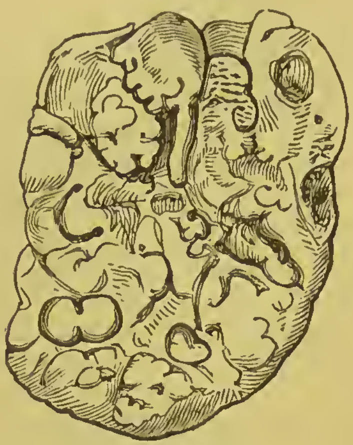
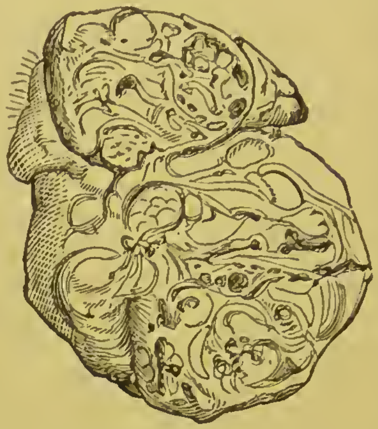


Fig. 964.†



Signs.—Enlargement of the testicle, as a solid, heavy tumour, of rapid growth, is the almost infallible indication of Encephaloid cancer. The unbroken tunica albuginea gives a hardness uniformly over the tumour, and a smoothness of surface, which really does not belong to encephaloid cancer; and which ceases subsequently, as the mass softens at parts into an elastic, pulpy, semi-fluctuating tumour, or when the tunic is ruptured and the mass protrudes. There is commonly little tenderness or pain; or if there be, it is dull, not acute or lancinating. When the cord has become involved, it is enlarged, and feels thickened and full; so that the vas deferens cannot be distinguished. Shooting pains extend along the cord to the groin and loins. As the disease advances, constitutional symptoms are evinced by cachexia, and a breaking down of the general health; the patient having been at an early period of the disease often in a robust, fleshy, and florid condition of health. The age when cancer of the testicle most commonly appears is from twenty to forty; it is rare after sixty, but it may be met with at any period of life, from the earliest infancy to old age.

The *diagnosis* from other tumours of the testicle is mainly determined by the solidity and weight of Cancer Tumour, with its rapid growth; but it must be distinguished from acute orchitis, and from chronic enlargement of the testicle,—syphilitic or scrofulous. The symptoms of inflammation, or the constitutional condition, respectively exclude these *Swellings* of the testicle from the question of diagnosis; and the various forms of Tumour are severally excluded by reference to the above-named characters. Thus, Cancer Tumour of the testicle differs from *Cystic* Tumour in all these particulars,—its solidity, weight, and rapidity of growth; from *Fibrous* Tumour, if such should occur, it differs in the far greater rapidity of growth; and from *Cartilaginous* Tumour, the difference in this respect is equally significant. As compared with *non-transparent Hydrocele*, and with *Hœmatocele*, respectively, the solidity and weight of Cancer Tumour are distinctive. But often the diagnosis can be accurately ascertained only by puncture of the Tumour, in order to subject to microscopic examination the substance or fluid from the mass in question.

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* St. Mary's Hosp. Mus., K. *e.* 11. Medullary cancer of testicle; section, showing cystic form of the cancer-substance, which was soft and elastic, of whitish colour, but marked in parts with brownish pink and blood spots. Some of the cysts contain others—sub-cysts; and, under the microscope, the contained substance consisted principally of large cells, including nuclei and nucleoli. The tumour was the size of a large cocoa-nut; and is distinctly enveloped by a dense fibrous capsule (not seen in figure). It had been growing for seven years, with little pain until the last two years; but the patient's suffering had never been severe. His age, forty-three. Castration was performed; and, on leaving the Hospital, he was quite well. (William Coulson.)

† Roy. Coll. Surg. Mus., 2396 c. (Canton.)

Scirrhous cancer far less frequently affects the testicle; a few examples only of this form of the disease having been recorded.

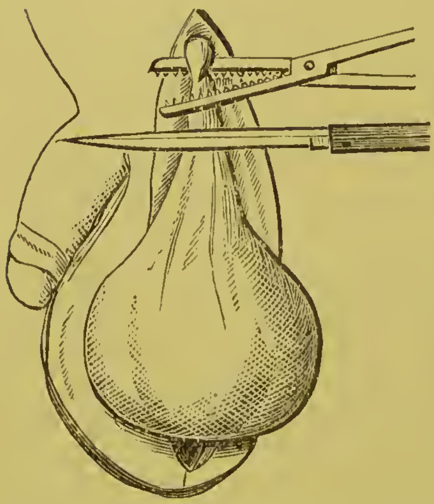
The *signs*, as distinguished from encephaloid cancer, are greater solidity, hardness, and weight of the testicle; but the tumour is not disposed to attain so large a size, nor to undergo ulceration. It is characterized also by slow growth, but the cord and lumbar glands at length become enlarged and indurated. Secondary cancer of other organs is unfrequent, and cachexia is generally less marked. The disease occurs at a later period of life.

Treatment of Cancer of the Testicle.—Castration is the only cure; provided that the whole of the disease can be thus removed. Consequently, when the disease is entirely local—affecting only the testicle —the operation may be performed, and with an equal chance of success, as after the removal of cancer in other parts. When, however, the spermatic cord is involved, and perhaps also the lumbar glands, forming a tumour more or less perceptible in the abdomen, castration will be unjustifiable.

The *results* of the operation have been unsatisfactory both in the localized and extended conditions of the disease. Thus, in the latter condition, of thirty-six cases collected in the "Medical Times and Gazette" (vol. xix.), three died within a week; two died within six weeks; and two within three months of the operation. In each case, there was disease of the lumbar glands or lungs, or both. When the disease, being local, has been completely extirpated, the tendency to secondary cancer, particularly in the lungs, is remarkably strong; and life may be prolonged only by a short period. On the other hand, encouraging results have been obtained by operation, although not more so than by leaving the disease to its natural course of duration. One patient, under Professor Humphry's observation, lived four years, and died, as was believed, of phthisis. A similar period of existence, in another case, was known to Sir B. Brodie, and the patient then remained well. Mr. Curling also relates four cases in which the patients were well at the respective periods of ten, four, nine, and twelve years after the operation. Without operation, in two of the above-mentioned thirty-six cases, the disease terminated fatally in a period of four months from the time it was first observed in the testicle; but cases have been recorded in which life continued for five, and even fifteen years!

CASTRATION.—Removal of the testicle is a very simple operation, but certain practical directions of importance should be observed. The pubes having been shaved on the side of operation, the patient should be drawn to the end of the table; so that resting there on his buttocks, the thighs and legs shall hang down, and give fair room for handling the tumour. The Surgeon standing in front, between the patient's legs, grasps the tumour posteriorly with his left hand, making the scrotum tense in front. Then, a bistoury is entered opposite the external abdominal ring, in order to reach the cord sufficiently high up that, when it comes to be divided, the cut stump, which is apt to retract, shall be freely accessible for ligature of the vessels. On this account, it may sometimes be advantageous to expose and isolate the cord, before removing the testicle from the scrotum. The incision is carried down longitudinally, from the external ring, over the anterior surface of the tumour to the bottom of the scrotum; or if the mass be of very large size, or the skin affected, a double elliptical incision may be made, enclosing a portion of the scrotum. It will seldom be requisite to remove any apparent redundancy of healthy integument, as the scrotal skin contracts and shrivels up very considerably after the operation. The tumour is readily turned out of the scrotum by a few touches of the knife, dividing its loose cellular connections; on the inner side, the knife should be particularly turned outwards, towards the tumour, in order to avoid puncturing the urethra, or opening the tunica vaginalis of the opposite side. Having detached the testicle and isolated the cord, the latter is seized between the thumb and finger by an assistant, or with a vulsellum, and held in position. (Fig. 965.) The cord is then divided by a stroke of the knife below this point, and the testicle completely removed. The spermatic artery, and probably two or three cremasteric branches, will require ligature. This mode of securing the vessels is preferable to tying the whole cord, a practice adopted by some Surgeons. But if there be any fear of retraction of the cord through the ring into the inguinal canal, it should be ligatured and retained in position by a strip of plaster over the ends of the thread. Scrotal vessels generally cease to bleed by sponging with cold water. Sutures are not required, the edges of the scrotal integument falling into apposition; and the wound, being dressed with a strip of wet lint, heals by granulation from the bottom.

Fig. 965.



In the after-dressing, bagging in the lower part of the scrotum must be prevented. Secondary hæmorrhage may necessitate a re-opening of the scrotum, which must then be lightly stuffed with wet lint. Retraction of the cord into the inguinal canal would render it very difficult to follow up the source of hæmorrhage in that situation; and a serious or even fatal loss of blood might take place, by its escape into the cellular texture of the groin and pelvis, without much external hæmorrhage.

Atrophy of the Testicle consists in the partial or complete absorption of the secreting portion of the gland—the tubuli seminiferi —leaving only the fibrous tunica albuginca, and septa between the lobules, as the remnant organ. The epididymis generally remains; its full size contrasting with that of the testis, which may be reduced to the size of a bean, or perhaps a mere nodule, having still an ovoid shape, but of flabby softness, and slipping about in a pendulous scrotum, when compressed between the thumb and finger. Impotency and loss of sexual power attend this condition, if both testes are atrophied; but the wasting of only one is often compensated by enlargement and increased functional power of the other.

Testicular atrophy may be the result of various coexisting structural conditions, which have already been described. *Hydrocele* is an occasional cause, by pressure of the fluid in the tunica vaginalis; and sometimes in consequence of the contraction of lymph effused in chronic hydrocele, or more frequently in *Hœmatocele*. *Diseases* of the testicle, also, result in absorption of the glandular substance; somewhat in proportion to the extent and persistence of any morbid deposit, or the formation of new growths, within the testis. Thus, atrophy may ensue from orchitis, acute or chronic; and more especially in the chronic form, with syphilitic intertubular deposit, or with scrofulous intertubular deposit. Obliteration of the *vas deferens*, from inflammation, is apt to cause atrophy of the testis; although the function of the organ may be thereby long suspended or lost without this result. *Varicocele* is an occasional cause, and obliteration of the spermatic veins by *operations* for the cure of this condition. Occlusion of the *spermatic artery*, as by an abdominal aneurism, has been known to induce testicular atrophy. *Hernia*, oft recurring or irreducible, has the same effect, probably by compression of all the constituents of the cord. The pressure of a truss, constantly worn, will act in like manner, and may result in atrophy of the testicle. Elephantiasis of the scrotum may be mentioned, as having the same effect. *Functional excitement of the organs*, from excessive venery, or from self-abuse, has an atrophying influence; and *injury* of the back of the *head*, a similar tendency, apparently by affecting the cerebellum; but injury or diseases of the *brain* or of the *spinal cord*, attended with paralysis, are not unknown as causes. In *elderly persons*, the testes are rather small and flaccid, but otherwise healthy; and the epididymis is sometimes thickened and indurated, with a similar state of the vasa deferentia, and opaque white spots in their walls.

No particular *Treatment* can be directed for a condition, the causes of which are so diversified and often irremovable. And any beneficial effect must be of a preventive character; the restoration of a lost portion of secreting structure being impossible.

FUNCTIONAL DISORDERS OF THE TESTICLE are associated with Functional Disorders of the whole Generative Apparatus, constituting Spermatorrhœa and Impotence.

Spermatorrhœa, or Seminal Emissions, easily excited and oft recurring. This disorder may occur either as *passive* discharges of seminal fluid, without much, if any, ejaculation or even previous erection, or as emissions, with *spasmodic* ejaculation and perhaps erection. In the one form of the disorder, seminal discharge takes place before erection; in the other, erection and ejaculation are often simultaneous acts, or erection may subside before ejaculation. In both conditions therefore connection is impracticable; and thus there is loss of sexual power, and apparently, at least, of procreative power.

Passive Spermatorrhœa denotes an excitability of the testes as secretory organs, whereby an excessive secretion or flux of seminal fluid is easily provoked, usually of a thin spurious character; and accompanied with irritability of the ejaculatory muscles, and of the erector muscles of the penis; while the constitutional condition is one of general debility.

The common *cause* of this state of mixed generative irritability and constitutional debility is habitual masturbation or self-abuse. This pernicious habit is acquired often at an early age, before puberty, by evil example or conversation among boys, who are intimately associated in Schools and other Institutions. A practice thus engendered, before moral control has yet been developed, and indulged in ignorance of its sad consequences, may be rectified only perhaps by marriage, or perhaps continued until it has wrecked its victim,—physically, intellectually, and morally. Spermatorrhœa is less frequently the consequence of suppressed sexual desire. It seems also more common in the upper and middle, than in the lower ranks of life, regarded socially; and among the educated and studious, than among those who have early followed some bodily avocation, or have been accustomed to the healthful games and outdoor pastimes of youth.

At first, sensual emissions happen only occasionally; once a fortnight or in a week, and usually in the morning between sleeping and waking, or as nocturnal emissions. After a while they become more frequent, perhaps three or four times a week, and occur during the day; under any slight emotional excitement, a word or even a look; or from some slight irritation, as by the movement of a carriage, or by any straining exertion, especially at stool. Ultimately, the emissions occur every twenty-four hours, and sometimes twice or thrice daily; the semen flowing back into the neck of the bladder, and escaping with each act of micturition or defæcation.

The physical consequences of spermatorrhœa are evinced by general debility, and disorder of the various functions; indigestion, palpitation of the heart, breathlessness, nervousness, epileptic and amaurotic symptoms, or even paralysis. The intellectual and moral decay are manifested by a general impairment of mental vigour, especially inability to fix the attention, and loss of memory; and by loss of moral courage, great depression of spirits and despondency or despair, shyness, reserve, and solitariness. Altogether, the pallid, vacant-looking, dejected, and lonely victim of spermatorrhœa, in its advanced stage, is a wretched spectacle which can scarcely be mistaken. He is often made worse, and his mental sufferings are aggravated, by reading some of the abominable and lying publications of quacks and extortionists; he is thus also entrapped into their dens, where his worst fears are speedily confirmed by personal influence, and his pecuniary resources drained to the last shilling, or incredible sums abstracted for promised cure. In one such case of imposition, a gentleman came to me for relief, whose penis was strangulated at the root by means of a broad metallic ring, furnished with a screw which tightly compressed a plate of metal on the urethra; the whole contrivance forming a vice in which his penis had been placed by one of the daily advertising impostors and which he had been ordered to wear for the ostensible purpose of stopping seminal emissions. Of course, the pain of approaching strangulation, daily increasing, daily compelled the patient to visit his merciless torturer; and when the poor victim came to me, his penis had become swollen to the size of a saveloy sausage, burying the vice, and the integument was rapidly passing into gangrene. I removed this instrument of torture, only just in time to save the organ.

Spasmodic Spermatorrhœa differs only from the more passive form of seminal emissions in the increased irritability of the ejaculatory and erector muscles of the penis, and of the prostatic portion of the urethra where the ejaculatory ducts open. It is not unfrequently coexistent with some disease of the generative organs,—stricture, varicocele, or neuralgia of the testicle, which may be the source of local irritation. Residence in a hot climate seems to have some predisposing influence; and the affection occurs usually at a later period of life than passive emissions in men, from the ages of twenty-five to forty.

Treatment.—The removal, if possible, of any source of *irritation* is the primary indication. Thence, the habit of masturbation must be corrected, whenever its practice can be discovered; and the patient should be encouraged to make a confidential acknowledgment respecting a matter of such vital consequence to his health and happiness. The influence of evil example should also be withdrawn, in youth; and the mind of an adult patient may have to be disabused of the groundless apprehensions which have been instilled into it by some rapacious impostor. Any source of local irritation, as a cause of spermatorrhœa, must be removed when practicable.

Remedial treatment comprises both constitutional and local measures. *Constitutional* treatment consists in the administration of tonics to restore a healthy state of both the muscular and nervous systems, and in the use of sedatives to allay irritability. Of tonics, the preparations of iron are most efficacious; and particularly the sesquichloride of iron, in doses of from fifteen to thirty drops in half a wineglassful of water thrice daily. Strychnia, in doses of one-twelfth of a grain, made into a pill, with or without the sulphate of iron, forms a tonic anti-spasmodic preparation of great value. Sedatives are less beneficial than tonics; yet, in spasmodic spermatorrhœa, a night pill of belladonna, or of hyoscyamus and camphor, may perhaps be advantageously given to subdue the local irritability which favours the seminal emissions. Suppositories of pil. saponis, ten grains, are, according to my experience, preferable as acting topically. The cold hip-bath, or sluicing the perineum with cold water, night and morning, is a most serviceable local tonic. *Hygienic* measures must also be carefully attended to, as a part of the constitutional treatment. A plain, unstimulating, nutritious diet is essentially requisite; rigorously excluding peppers and other condiments, which are apt to irritate the rectum and provoke seminal emissions during defæcation. The stomach should never be overloaded by a heavy meal; and a daily action of the bowels should be secured by gentle aperients, when necessary. A dinner pill, consisting of the compound rhubarb pill with hyoscyamus, will answer this purpose far better than colocynth or any other irritant purgative. The invigorating influence of daily exercise in the open air, and of outdoor amusements, with perhaps change to a bracing climate, can scarcely be overlooked; but relaxation from study or the excitement of business, and freedom if possible from the pressure of anxiety, are no less restorative; while every encouragement must be given to cheerfulness and hope.

All this constitutional treatment not unfrequently fails to cure the spermatorrhœa; the local irritability of the prostatic urethra still remaining. Recourse must be had to the application of nitrate of silver along the under surface of this portion of the urethra, to the orifices of the ejaculatory ducts.

This method of treatment, first prominently brought into notice by Lallemand, can be effected by means of the *porte-caustique*, or by a *syringe-catheter*. The former instrument is also a kind of catheter, but which acts by protruding its end, carrying the caustic. This portion, however, is apt to be grasped by spasmodic muscular action, and can then be returned only with difficulty into the shaft; or it may perhaps become fixed in the prostatic urethra, owing to some defect in the instrument, as happened in the person of a gentleman on whom Dr. Humphry was operating. In the syringe-catheter, a piece of sponge, charged with a solution of the caustic, is compressed by pushing down a firm stylet within the catheter; whereby the solution is forced out of about a dozen minute apertures near the end of the instrument. This mode of applying the caustic has the advantage of being safer and more manageable than by the porte-caustique. It is highly commended by Mr. Erichsen, who uses a solution of the strength, generally, of one drachm of the nitrate to an ounce of water. In applying either of these instruments, the prostatic urethra is known to be reached by the distance to which the shaft has passed, and by feeling with the finger in the rectum, also by the sensitiveness of the part. Considerable irritation, pain, and bloody or muco-purulent discharge, follow the operation; with perhaps an aggravation of the nocturnal emissions. These subsiding in a few days, the cure may be complete; or the caustic may have to be reapplied when the urethra can bear it, at intervals of a week or two; and sometimes no good results from the treatment.

Impotence signifies an absence, loss, or premature decay of sexual and procreative power, with generally a corresponding negation of sexual desire. The seminal secretion may be absent; a condition known as *Asperma*, and which contrasts with that of Seminal Flux. But, as in that condition, any slight secretion is often thin and spurious; not containing spermatozoa, or only in scanty quantity.

It is highly important not to mistake the nature of the *prostatic* secretion; which may be discharged from the urethra as a tenacious fluid, like white of egg, in small quantity, and following the urine, or expelled during defæcation, especially when accompanied by a straining effort. Such discharge is quite consistent with the full possession of sexual and procreative power; or with the absence of seminal fluid, and consequent impotency.

The *cause* of impotence may be some congenital or acquired deficiency of, or affecting, the genital organs.

Congenital impotency is sometimes a cerebral imperfection, as occurring in idiots; or from a want of that concurrence of forces which is requisite for the complicated process of generation. This constitutional impotence is not necessarily associated with any discoverable imperfection in the organs, or any obvious defect of bodily formation. It may, indeed, be associated with full intellectual vigour; and with a physique endowed with great muscular power, developed also by athletic exercises. But more often, the external indications of virility are defective when sexual power is wanting.

Acquired impotence may be the result of prolonged sexual excesses, or of habitual physical exertion; in either way exhausting the nervous energy. Occasionally, it follows injuries of the head, and usually when the patient is convalescent. Wasting of the testicles is then perhaps the first announcement of generative failure; and this may continue, or the sexual power gradually returns.

The *Treatment* of Impotence must have reference to its various causative conditions; consequently, it is often incurable.

Neuralgia of the Testicle.—This affection of the testis resembles neuralgia as occurring in other parts. The pain varies in character and severity; being sometimes dull and aching, or darting and so acute as to make the patient roll on the floor in sweating agony. Often the pain is paroxysmal.

Various *causes*, local and constitutional, may give rise to this suffering; any source of irritation in an adjacent organ, as stone in the bladder, kidney, or ureter; or disease of any part of the urinary apparatus; varicocele; gastric or hepatic irritation; or it may arise from a depressed state of the general health, especially as the consequence of malarious influence, and then the pain usually recurs periodically. The testicle itself is generally healthy in its structure.

Treatment of a curative character implies the discovery and removal of the cause in operation, and these requisites cannot always be fulfilled. Tonics, especially quinine and iron, are remedial; particularly in the periodic form of the neuralgic affection. The hypodermic, or perhaps the testicular, injection of morphia might be worthy of trial. An ointment of aconitina—one grain to a drachm of lard—I have known to allay the pain; or fomentations with hot water, as hot as can be borne, will sometimes afford relief.

Ought *castration* ever to be performed as a last resource to relieve pain, or in compliance with the urgent request of the patient? The question is a serious one, inasmuch as it relates to the removal of an organ, not structurally diseased, and important in itself; and which may almost at any moment cease to afflict the patient. But this question should be considered primarily with reference to the probability of thus removing the cause of neuralgia, as this painful affection will at length undermine the general health, and also with regard to the urgency of the patient's request when the nature of the case is explained to him, in an intermission of pain. Sir A. Cooper was induced by the latter consideration to perform castration in three cases of the kind; and other Surgeons have deemed it advisable to do the same. Yet the operation is justifiable only in rare and exceptional cases.

Malposition of the Testicle.—In the fœtus, the testes are contained within the abdomen, in the lumbar region; whence they gradually descend through the inguinal canal into the scrotum, a change of situation which is usually completed before birth. But, by an arrest of development, this descent of the testis may be retarded until after birth, and it may then never take place completely. The descent of this organ is delayed till a few months, or a year, after birth, in about one infant in five. It occurred at a later period in many cases which came under Sir A. Cooper's observation; the testis descending at from one to seventeen years, or even twenty-one years. Complete descent fails to take place in about one person in 1000; and then the testis may be permanently retained in the abdominal cavity, or in the internal abdominal ring, or in the inguinal canal just above the external abdominal ring. The right or the left testis is nearly equally liable to these malpositions; and rarely it happens with both testicles.

The *causes* of any such failure of descent would seem to be a deficiency in the force, whether it be the contraction of the fibres of the gubernaculum or some other force, whereby the descent of the organ is effected; or, sometimes, an impediment to the process; as an imperfect development of the mesorchium, or adhesion to one of the viscera or to the abdominal wall, consequent on intra-uterine peritonitis; imperfect patency of one of the inguinal rings, or some obstacle in the inguinal canal. Shortness of the vas deferens or of the spermatic vessels may also be regarded as a cause of retention; though the cord is often tortuous or convoluted.

The condition of the retained testis, as to its *structure* and *function*, is variable. It has been found of full size, rarely; generally, it is imperfectly developed, being smaller than natural, and its gland-tissue remaining immature as in the infantile organ. Or, it may be atrophied, and have undergone fibrous or fatty degeneration, obliterating any trace of gland-structure. Functionally, the organ is incompetent. This want of secretory power for the production of spermatozoa, is of little consequence when the other testicle has descended and is healthy; the one organ being quite sufficient for generation. But when both organs are retained, the procreative power will usually be completely wanting; the individual is absolutely impotent. He may have full sexual desire, power of erection, and emissions during connection; but the spurious seminal fluid contains no spermatozoa, and has no impregnating influence.

Diseases of retained Testicle.—The organ is liable to *inflammation* and *malignant disease*, *encephaloid* cancer more particularly; and orchitis is especially apt to occur when the testis is lodged in the inguinal canal, the inflammation arising from gonorrhœa or from injury. The diagnosis between a retained testis in that situation, and inguinal hernia, or even bubo, must be decided by reference to the symptoms of these conditions. Mistakes have been made by eminent Surgeons, and Ricord nearly mistook an inflamed testis for a bubo. *Congenital hernia* not unfrequently accompanies and complicates undescended testis in the inguinal canal. The testis may be unable to bear the pressure of the truss requisite to prevent the descent of the hernia; while in an operation some difficulty is often experienced, owing to adhesion of the gland and bowel.

Mis-descent of the testicle sometimes takes place; the organ having descended within the abdomen, it escapes into the perineum near the anus, or into the pelvis; or through the crural ring and saphenous opening, thence upwards upon the abdomen, so as to simulate crural hernia, or is lodged behind the fascia in the upper and inner part of the thigh.

Inversion of an undescended testis is occasionally met with; the vas deferens and epididymis presenting forwards, and the body of the organ looking backwards. The diagnosis of any diseased condition is then rendered more difficult. If hydrocele coexists, the fluid swelling will be situated behind the testicle.

Diseases of the Vesiculæ Seminales.

These two oblong, sacculated receptacles for semen lie at the base of the bladder, and converge from behind forwards to the base of the prostate; the vasa deferentia come forwards between them to that gland, and each vas there joins with the opening of the corresponding seminal vesicle, to form the common ejaculatory ducts. Thus situated and connected, the seminal vesicles are not uncommonly diseased in company with the testicles, or sometimes independently of those organs; and these diseases may induce or aggravate disease of the bladder, and less frequently, of the rectum.

The seminal vesicles are subject to *inflammation*, arising independently or in consequence of gonorrhœa; and they are liable to *chronic* enlargement, especially of a scrofulous character, and to *malignant* disease.

Diagnosis is much facilitated by the situation of these bodies, as they lie within reach of the finger passed into the rectum.

Treatment must be conducted on ordinary principles.

CHAPTER LXVII.*

INJURIES AND DISEASES OF THE FEMALE GENITAL ORGANS.

A LIMITED notice only can be taken of some of the Diseases which, affecting or specially pertaining to the Female Genital Organs, come under the observation of the general Surgeon; and principally with regard to the operative procedures requisite for their cure.

These *Diseases* relate to—(1) the External Organs, or the *Vulva*, in its several parts, and the *Vagina;* with which may be conveniently associated the *Perineum;* (2) the *Uterus*, and Fallopian Tubes; (3) the *Ovaries.*

The External Organs are also liable to *Injuries;* in the form of Wounds of the Vulva, or of the Vagina, and Laceration of the Perineum; or the introduction of Foreign Bodies.

(1.) External Organs.—Wounds of the Vulva present nothing peculiar, excepting the proneness to copious hæmorrhage, owing to the natural vascularity of the labia, nymphæ, and clitoris. But the tendency to primary union is remarkable. The treatment, therefore, is by suture and simple dressing.

Wounds of the *Vagina* are even more rare than of the vulva. In Mr. Erichsen's practice, a remarkable case happened; a cedar pencil, five inches long and cut to a point, had been forced up through the posterior wall of the vagina of a young woman into the abdominal cavity, and there it transfixed two coils of the small intestine. After a sojourn of eight months, it was extracted by an incision through the anterior abdominal wall, midway between the umbilicus and Poupart's ligament, where its point was engaged in the fascia transversalis. It had occasioned repeated attacks of peritonitis, and after its extraction, death resulted from that cause. There is a specimen in St. George's Museum of rupture of the vagina, in an aged woman, under sexual intercourse.

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* Revised and Enlarged by Robert Barnes, M.D.

LACERATION OF THE PERINEUM.—This injury happens occasionally during parturition; in consequence of the large size of the fœtal head, or from rigidity of the perineum; or sometimes under operations, manual or instrumental, skilfully or unskilfully executed. During parturition, laceration or rupture of the perineum occurs in the passage of the fœtal head. It varies considerably in its extent and consequence. Perineal laceration may be regarded as of four degrees: that which is limited to the anterior edge of the perineum; that which extends backwards through the whole length of the perineum to the sphincter ani; that in which the sphincter is torn through; that in which not only is the sphincter torn through, but where more or less of the recto-vaginal septum is also torn. A combination of laceration and sloughing is sometimes met with; the perineum being torn through, and the recto-vaginal septum destroyed by sloughing, from prolonged impaction of the fœtal head. The fissure, directly resulting from laceration and increased by loss of the septal substance, may be complicated also by the subsequent formation of dense bands of imperfect cicatrix; thus presenting the most difficult form of lesion in regard to treatment.

The *consequences* of laceration depend upon its extent. Whenever it passes beyond the anterior margin of the perineum, and especially when it involves the sphincter ani and perhaps the septum, there will be a tendency to prolapsus of the uterus and bladder, of the rectal mucous membrane, or of all these parts; and with the latter condition, as depending on the sphincter having given way, there will also be inability to retain the fæces—incontinence of fæces. This trouble is especially marked when the stools are loose or liquid.

Treatment.—Operative interference is absolutely necessary in all degrees of perineal laceration, except that of a slight rent in the front margin of the perineum. This will, generally, heal by rest and cleanliness, with perhaps an occasional touch with nitrate of silver.

The *operation*, in each of the other degrees of further laceration, is essentially the same; a plastic procedure, which consists in freely paring the edges of the fissure, and bringing them together by quilled sutures, to procure union by adhesion. *Prior* to operation, the patient's general health should be brought into the best possible state, and any source of local irritation removed; as these two conditions will mainly determine a successful result. The operation is then performed as follows:—The bowels having been thoroughly emptied, chloroform is administered, and the patient placed in a lithotomy position; a duck-billed speculum is passed into the vagina, so as to elevate the upper floor, and thoroughly expose the perineal fissure. This must then be freely pared throughout its depth and extent, on either side; thus to prepare two raw surfaces, together of nearly a horseshoe shape. *Immediate or primary operation.*—This should be performed within twelve hours of the occurrence of the injury. When the opportunity for this is offered, no paring of the surface is usually necessary. But occasionally an irregular mass of connective tissue projects so as to interfore with neat apposition of the two sides of the wound. Such a mass may be snipped off. The parts are then brought together by suture. Beginning at the hindmost part, a moderately curved needle, either mounted on a handle or carried by forceps, is passed deeply into the tissues just behind the level of the anus. It is carried across, well buried beneath the raw surface, to emerge at the opposite side at the same level. A second suture is passed at a distance of three-quarters of an inch in front, also buried beneath the surface. Two or three more sutures are passed so that they are seen on the surface of the wound. The width of the raw surface averages about an inch. Unless the surface be thoroughly pared, so as to form a good thick cushion instead of only a thin cutaneous support, the tendency to prolapsus will continue; and any point of undenuded surface will probably be followed by the establishment of a fistulous opening. Hæmorrhage is often rather free, and the fissure should not be brought together until this has ceased. Ice is the best styptic. Division of the sphincter ani, on each side of the coccyx, was recommended by Mr. Baker Brown, in order that its action should be paralyzed and all tension of the part be overcome. This addition to the operation may be useful, when the laceration passes high up into the recto-vaginal septum. The parts having ceased to bleed, and coming freely together into *easy* apposition, the quilled sutures are applied at as many points as may be necessary to bring the surfaces into one line of union. For this purpose, two pieces of bougie may be used; or two quills, rods of glass, or perforated metal or ivory bars. Fine whipcord is the best material for the sutures. By the thickness of the raw surfaces, and the firm support of the lateral rods, the superficial edges of the fissure are often seen to be everted. In concluding the operation, therefore, it may be advisable to bring the *edges* together with a few points of ordinary interrupted suture; using metallic wire in preference to fine silk. But some operators discard the quills, trusting to simple twisting. C. Brooke had the earliest successes with his bead-sutures.

After-treatment is very important. It consists in preventing any intestinal action for eight or nine days, by keeping the patient sufficiently under the influence of opium; and averting any dribbling of urine over the raw edges, by retaining a catheter in the bladder, furnished with a long india-rubber tube to carry off the urine free of the person. Scrupulous cleanliness of the parts is absolutely necessary. The strength must be maintained by abundant fluid nourishment. The sutures should not be removed for a week; and rest in the recumbent posture be still continued for two or three weeks longer, lest the recently united parts might yield.

The prolonged recumbency incidental to this operation exerts a further beneficial influence in relieving the prolapsus. The turgid and ulcerated os uteri recovers a healthy state, and the relaxed uterine ligaments have time to regain their tension.

The *results* of this operation require further investigation. But the extent of laceration, and sometimes loss of substance, materially affect the issue. When the laceration involves the sphincter ani, and is consequently attended with incontinence of fæces, an operation for the restoration of the perineum will effectually afford the support necessary for control over defæcation. But the lesser evil consequence of such laceration—prolapsus—will be less certainly remedied. It may be cured temporarily, the prolapsus subsequently returning. *Failures* of the operation sometimes occur; more often as the result of extensive laceration, and perhaps loss of substance. If the patient's health is bad, or if erysipelas or other Hospital infection supervene, the wound may slough, and union be frustrated. Recto-vaginal fistula is an occasional result, principally from incompleteness of the operation itself.

FOREIGN BODIES IN THE VAGINA.—Various foreign bodies may be introduced into the vagina, accidentally or intentionally, and in the latter case occasionally with malicious intent. Thus, by a fall, the spike of an iron railing has been known to enter the vagina; in the Museum of the Royal College of Surgeons, there is a glass tumbler which a woman had thrust into her vagina, for some purpose best known to herself; and I have extracted a piece of swollen sponge from the os uteri, which a young woman had passed up her vagina, with the view of preventing the liability to conception from sexual intercourse.

The danger arising from the introduction of foreign bodies into the vagina depends upon their nature, the amount of damage done, and the period of impaction. A hard, rough body, forcibly thrust up the passage, is often productive of copious *hæmorrhage*, especially by laceration of the labia externally. Hæmorrhage from lesions of the vagina may mostly be stopped by pressure, or by plugging, aided by styptics, as perchloride of iron or tincture of iodine. But it is sometimes necessary to pass a curved needle, armed with a wire suture, well under the bleeding surface. On twisting the suture, bleeding is commonly controlled. A pointed body may *perforate* the vagina, as in Mr. Erichsen's case of punctured wound already mentioned. The continued impaction of a foreign body gives rise to *vaginitis* and discharge, requiring appropriate treatment, even when the substance has been removed.

DISEASES OF THE EXTERNAL GENITALS.—HYPERTROPHY OF THE LABIA, OR OF THE CLITORIS.—These parts are liable to enlargement, of a fibro-cellular character, as thickened and pendulous labia; or sometimes forming an apparently distinct outgrowth. This hypertrophy, or tumour, seems to be the result of prolonged irritation, in connection with some fissure of the part, or from morbid vaginal discharge. A fibro-cellular outgrowth of the clitoris, which had attained to the size of a very large cocoa-nut and weighed thirty ounces, was removed at the Royal Free Hospital. I gave a short description of the growth in the *Lancet*, August, 1857.

Excision is the only remedy for these conditions. Hæmorrhage is often profuse, the blood coming from a number of small vessels. A good precaution, therefore, is to transfix the base of the mass by means of hare-lip pins and twisted sutures, before using the knife. The outgrowth form of hypertrophy may be removed with less hæmorrhage, by écraseur or ligature, or the galvanic cautery-wire.

CONDYLOMATA or VERRUCÆ are of common occurrence, in consequence of prolonged irritation from syphilitic or gonorrhœal discharge, and uncleanliness. A large cauliflower mass is at length formed. Its removal can sometimes be effected, like warts of the prepuce in males, by dusting the part with a powder consisting of equal proportions of pulverized savine and copper. Excision, however, must generally be resorted to when the mass is considerable; and this is accomplished most readily with scissors curved on the flat.

Abscess of the labium forms, not unfrequently, in consequence of some injury to the part in sexual intercourse. It is most liable to happen soon after marriage, when the parts are as yet unaccustomed to attrition; and in prostitutes, from the contingencies of promiscuous intercourse. The abscess seems to arise by rupture of one of the veins in the labium; and when it bursts on the inner side, after the lapse of perhaps only a few days, or is laid open by incision, it discharges a mixture of venous blood and fœtid pus.

Cystic Tumours are occasionally met with in the subcutaneous cellular tissue of the external genitals. They occur in two situations; either about an inch and a half within the vulva, a little below the middle of one or other side of the vagina, and as the result of enlargement of Cowper's glands; or in the cellular texture of the labia, where the cyst attains to a larger size—that of a chestnut or even a small orange, and resulting from the enlargement of a mucous follicle. In both situations, the cysts contain a glairy fluid, perhaps tinged with blood from any slight injury of the part.

Diagnosis.—Cysts may be distinguished from *abscess* by the absence of inflammatory symptoms, or of such symptoms in the history of origin. But a cyst, sometimes becoming the seat of inflammation, is converted into an abscess. The diagnosis will then be most difficult or impossible, unless the patient's own evidence can be trusted as to the previously distinct formation of a cystic swelling. From *inguinal hernia* descending into the *labium*, a cyst is distinguished by its incompressibility, irreducibility, and the absence of impulse on coughing. Puncture of the swelling may of course be resorted to in any doubtful case, when the possibility of hernia is excluded from the diagnosis.

Treatment.—Any such labial or vaginal cyst can usually be obliterated by a free incision, and the introduction of a strip of lint to provoke suppurative granulation from the bottom of the cavity. Excision offers a more speedy cure; but the dissection, easy in itself, is somewhat embarrassed by the free hæmorrhage from the vascular texture of the labium. This may be arrested by pressure with a compress and T bandage.

Fibrous tumour occasionally forms in the labium, having usually a pyriform shape, and a firm, somewhat elastic consistence; sometimes attaining to a considerable bulk, so as to hang between the thighs. But it is painless, and not prone to ulceration, although its increasing size demands surgical interference to remove a mechanical inconvenience. The diagnosis must be made betwixt this labial fibrous tumour and a similar growth, the peduncle of which proceeds deeply from within the pelvis, but the tumour appears in the labium. Then, having defined its base, the tumour may be easily and safely *excised;* with little loss of blood, as the fibrous texture is only slightly vascular. When the growth is sessile, and embedded in the labium, *enucleation* can sometimes be performed; an incision being made, the tumour is readily shelled out. *Fatty* tumour of the labium is far more rare, and may be distinguished by its soft, inelastic consistence, and smaller size. But the treatment is similar,—removal by excision.

Epithelial Cancer is not very uncommon in the labia and vagina. It presents the same characters as in other parts. An irregular, undermined, indurated margin, an unhealthy grey surface, and a tendency to the production of warty granulations, and liability to bleed, are its most distinctive appearances. It may commence in, or extend into and up, the vagina; converting this passage into a hard, solid, open tube, having a tuberculated surface, of an ash-grey colour. This state of the vagina was well marked in a patient under my care at the Hospital. The inguinal glands speedily become infected. This affection occurs most frequently after middle age.

Treatment.—The disease may be removed by excision or by caustic; and any affected glands must also be extirpated. In the case just referred to, I freely cauterized the interior of the vagina with strong nitric acid, but only with temporary benefit. A speedy return of the disease is the, perhaps, invariable result of any interference.

Rodent ulcer is very rarely met with on the female genitals. It may be distinguished from epithelial cancer, by the absence of warty growth, by its slow progress, and by the freedom of the glands from infection.

This disease is amenable to excision.

Vascular or Erectile Tumours not uncommonly grow near, or just within, the meatus urinarius. Such tumours are broad-based or pedunculated, of small size, red and disposed to bleed, sensitive or painful. Pain in micturition, and in sexual intercourse, with occasional bleeding, lead to an examination, and then the source of irritation is discovered.

Treatment.—Complete removal of the growth is the only cure, and this may be effected by excision with curved scissors, ligature, or cautery. The submucous base must be removed with the growth; it will therefore be necessary to thoroughly expose the part for operation, and it may be desirable to place the patient under the influence of chloroform.

Œdema of the vulva is not very uncommon, the labia becoming swollen and tense, very painful, or affected with an intolerable itching, and sometimes cracked or ulcerated. This condition more often depends on obstruction to the circulation in an advanced stage of pregnancy, or in connection with ascites or general anasarca; but it may also be symptomatic of an enfeebled constitution,—resembling a similar œdema or anasarca of the scrotum in the male. Treatment will have perhaps little effect, when the cause cannot be removed; but, as a topical application, an astringent ointment—acetate of lead ointment, ℥i., with the extract of opium, ʒi.—may, according to my experience, prove most beneficial. Indeed, I have known the swelling thus subdued, and relief afforded, when otherwise life was unendurable. This should be combined with quinine and iron, as a tonic, with a nourishing diet, in a broken state of the constitution.

A *varicose* condition of the *veins* of the labia, or involving the whole vulva, is sometimes consequent on pregnancy or a uterine tumour. Inflammation or hæmorrhage from rupture of the veins is apt to occur; the latter especially during child-birth. The usual treatment must be adopted: the recumbent position, and cold lotions; or, in the event of hæmorrhage, compression or ligature of the bleeding vessel.

Pruritus of the labia, or of the entire vulva, is another complaint; and of which I have seen several instances. The labia—not swollen at first—become thickened and hardened, sometimes cracked, and exude a serous fluid, which drying on the parts, stiffens them the more; but this state is produced by the incessant scratching in vain to relieve the unbearable itching. This labial pruritus is mostly met with in married women, during the turn of life; and it seems to proceed from some ovarian excitement, evinced by tenderness on pressure over one or other iliac region; which is aggravated at the menstrual period, and accompanied with a rejuvenescence of morbid sexual desire, and perhaps leucorrhœa. Any local treatment to the part affected will rarely succeed; but blistering over the apparent source of irritation has, I have found, dispelled the torment from which the patient suffered. It is important to cure any complicating uterine disorder.

Closure of the Labia, or of the Vagina.—As the result of slight malformation, it often happens that the *Labia* are adherent, leaving perhaps a pin-hole opening for the trickling escape of urine. This defect is usually discovered in infancy, when the adhesion can be easily separated.

Treatment consists in simply running a probe between the labia, and then inserting a strip of oiled lint to prevent reunion. The cure is generally permanent.

Atresia or even absence of the Vagina is occasionally met with. This condition is sometimes associated with absence or imperfect development of the uterus. In exploring to determine the exact condition of things, when there is apparent absence of the vagina, a sound should be passed into the bladder, and a finger into the rectum. The nature and amount of tissue between the bladder and the rectum can thus be determined, and by carrying the finger high up into the rectum, the uterus and ovaries, if present, can be felt. A vagina can be constructed by a careful combination of incisions and stretchings, avoiding the urethra on the one hand, and the rectum on the other. This proceeding is commonly best carried on at several sittings. Dr. Barnes relates a case where impregnation took place after such restoration, and others in which the subjects married and did well. After the operation there is a great tendency to contraction. This is counteracted by wearing a Hodge pessary or a vaginal dilator for some time.

Closure of the *Vagina*, as the result of malformation or sometimes of adhesive inflammation in early life, is a defect less apt to attract attention, and seldom discovered until the period of menstruation. Amenorrhœa, or more correctly speaking, "occult menstruation," then arises from accumulated retention of the menstrual secretion. This is attended with a sense of bearing-down weight in the perineum, which suggest the necessity for an examination. Closure of the vagina may also result from cicatrices following on sloughing from injury during labour.

Treatment, here also, consists in opening the vagina, and tearing asunder the adherent walls with the finger or the handle of a scalpel; and then introducing a pledget of oiled lint, until the surfaces have healed separately.

Imperforate Hymen is another occasion of occluded vagina. This defect also will probably remain undiscovered until puberty. The accumulated retention of menstrual fluid at length causes distension and protrusion of the imperforate and thickened hymen beyond the vulva, with a bearing-down weight; while an elastic, fluctuating tumour can sometimes be felt above the pubes or in the iliac fossa.

Treatment.—An aperture must be made in the hymen; and this may be done by puncture with a trocar, and then enlarging the opening with a probe-pointed bistoury, or by making a free crucial incision. Complete removal of the hymen, by dissection, has been recommended by Mr. Baker Brown; but this extreme procedure seems unnecessary for the functional freedom of the vagina, and indeed might be followed by cicatricial stricture. In either mode of freeing the passage, the urethra must be carefully avoided; a precaution less easily observed when "the hymen is removed entire by a circular incision." An opening having been made, the retained menstrual fluid is discharged, often in a very large quantity, of syrupy consistence, and sometimes of offensive odour. The relief thus afforded is immediate. But the danger and fatality of this simple operative procedure is considerable. Peritonitis often ensues; not of a puerperal or contagious character, as was formerly suggested by Dr. Blundell and others, but apparently in consequence of some of the menstrual fluid finding its way upwards through the free extremity of the Fallopian tube into the cavity of the peritoneum, or by rupture of the tube, which, with the uterus, had previously undergone dilatation from backward distension with the accumulated fluid. That either of these two events should happen after the relief of tension by operation is remarkable; yet they seem to be established by the observations of Bernutz, Goupil, and Jonathan Hutchinson.

Partial imperforate hymen is occasionally met with. This condition, however, is no barrier to marriage, or to impregnation; or even to parturition, the hymen rupturing, usually, under pressure of the fœtal head.

Incision will be desirable to free the patient from any unhappy matrimonial restraint.

Stricture of the Vagina, having a fibrous or carcinomatous character, may occur, as in the rectum or other canals. *Fibrous* stricture is the result of inflammatory deposit, in the submucous cellular tissue; or it may appear in the form of cicatrix, consequent on ulceration. Either such condition would interfere with sexual intercourse and parturition; or prevent the free discharge of mucous and menstrual fluid. Examination with the finger will readily detect the cause of obstruction, and which may be brought into view by using a speculum. The stricture will generally yield to gradual dilatation, by means of bougies or tents of compressed sponge; but it may be necessary or advisable to cautiously incise the mucous membrane and submucous tissue with a probe-pointed bistoury, on either side of the vagina,—thus avoiding the bladder above and the rectum below; afterwards maintaining the passage by the occasional introduction of a bougie or pessary. *Cancerous* stricture requires no special notice; its pathology and treatment having reference to the disease which produces this condition of stricture. Dilatation will have no good effect, curative or even temporary.

Spasmodic Contraction of the Sphincter Vaginæ—Vaginismus.—This affection is usually characterized by extreme dread of sexual approach or even of examination by touch. The spasmodic contraction is partly reflex, the result of pain on touch, partly—perhaps mainly—hysterical.

The nervous system, indeed, is not seldom deeply impaired by the continuance of the local distress, and the attendant marital disappointment. Examination should be conducted under anæsthesia, and this must be to the surgical degree, in order to subdue the reflex irritability. Then, sometimes, no local condition is found, beyond smallness of the vulva. Often the hymen, even after months of married life, is unbroken. At other times remains of the hymen are seen, as caruncles or an imperfect ring, red, inflamed, irritable. Generally distension is not difficult during anæsthesia; but sometimes the vulvar ring is rigid. There are three principal methods of treatment. The first is forcible stretching, either by Barnes' speculum, or by the thumbs or fingers back to back. The second is to nick the perineum at the fourchette or the vulva with a knife, or to divide the sphincter vaginæ by subcutaneous incision. The third, frequently the most effectual, is to dissect off in a ring the remains of the hymen. This removes the main source of peripheral irritation. After any method, it is useful to abstain for a while from sexual relations, and to wear for some hours daily a vaginal dilator. This acts by wearing out the sphincteric irritability, by accustoming the parts to contact of a foreign body, and by giving rest. In minor cases, this plan is often sufficient by itself. The dyspareunia disappears, and pregnancy has often resulted. Constitutional treatment, calculated to improve the general health and to strengthen the nervous system, should go on *pari passu* with the surgical treatment.

Rectal and Vaginal Fistulæ.—Fistulous openings may exist in the Female Organs; between the rectum and vagina,—*Recto-Vaginal Fistula;* or between the bladder and vagina,—*Vesico-Vaginal Fistula.* These Fistulæ, and their modifications, have already been described, as thus designated, in previous parts of this work.

Prolapsus Vaginæ.—A falling down of the vagina is liable to occur; either in its anterior wall, with protrusion of the bladder, constituting *Cystocele;* or in its posterior wall, forming *Rectocele.* These conditions present the characteristic appearance of the rugous walls of the vagina, and are thus distinguished from prolapsus of the uterus, in which the os uteri descends, as the most prominent part of the protrusion. The sense of bearing down, and constant vaginal discharge—with the vesical irritability in cystocele—usually compel the patient to seek relief.

Treatment may be palliative or curative. The *former* consists in returning the protrusion, and supporting it by the introduction of a properly shaped pessary. *Curative* treatment consists in having recourse to a plastic operation; by paring off a strip of mucous membrane from below the meatus on one side round to the same point on the other side, and uniting the raw surfaces by suture. The width and length of the strip should vary according to the degree of prolapsus; the object being to sufficiently narrow the canal for the permanent support of the protrusion. As after other plastic procedures relating to these parts, the bowels should be confined by opium, and scrupulous attention paid to cleanliness; a catheter communicating with an india-rubber tube is retained in the bladder to carry off the urine.

Tumours.—The vagina may be the seat of tumours, springing from its walls. *Mucous* or fibrous *polypi*, *cystic* tumours, and vascular growths are here found. Their relations must be carefully made out before resorting to any operation. When the tumour grows from the posterior wall of the vagina, rectal examination will determine this question.

Removal of these tumours can be effected by excision or ligature.

(2.) The UTERUS is subject to various Displacements; and to the formation of Tumours, benign and malignant.

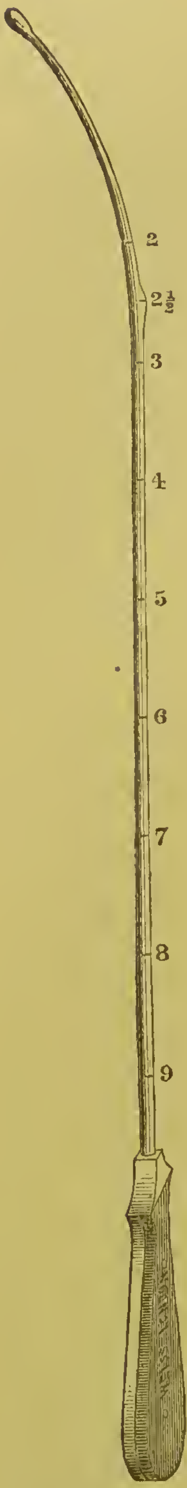
Displacements comprise: various alterations in the direction of the axis of the uterus,—*Anteversion*, *Retroversion*, *Lateroversion*, right or left; corresponding forms of *Flexion* or bending of the uterus upon itself; and *Prolapsus*, which, when complete, is distinguished as Procidentia.

The *causes* of these displacements are often congenital, but still more frequently accidental. They commonly date from labour, and are attended by imperfect involution of the organ. Exertion sudden and forcible, or long continued, causing pressure upon the softened uterus, turns the fundus backwards or forwards, depressing it. Engorgement and hyperplasia ensuing, the bulk of the organ is increased, and this increased leverage acting upon the fundus, increases and maintains the displacement. In many cases of retroflexion the enlarged body of the uterus is locked in the hollow of the sacrum, underneath the projecting promontory.

Treatment must be directed to the complicating conditions, as well as to mechanical rectification. As a rule, engorgement, inflammation, hyperplasia, enlargement, will not be effectually treated until the uterus is maintained in due position. This is the essential condition of successful treatment. The mere reposition by finger or sound (Fig. 966) is only useful for diagnosis. That it can be so effected proves freedom from adhesions or other obstacle. But the displacement is almost certain to recur, unless the body of the uterus be supported in its proper position by a suitable pessary. For prolapsus and retroversion, and for retroflexion, some modification of Hodge's lever-pessary can generally be relied upon. They are best made of flexible metal, which admits of accurate moulding to suit the particular case. Vulcanite rings, soft or hard rubber pessaries, are open to serious objections: they cannot be so nicely fitted, and they become foul and irritating.

Operative procedures have been devised for constricting the upper part of the vaginal passage, and thus supporting the prolapsed uterus. Dr. Marion Sim's operation consists in removing strips of mucous membrane, in the form of a horseshoe, from the *roof* of the vagina, under the bladder. Each curved strip should extend from just above the neck

FIG. 966.



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* Uterine sound.

of the bladder nearly up to the uterus, and be about half an inch in width. The mucous membrane being seized with a vulsellum, excision is best accomplished by means of a curved, blunt-pointed pair of scissors. The opposed denuded surfaces are then brought together by a series of wire sutures; observing that any bleeding has ceased before making the coaptation. The patient should be kept on her back, in bed, two or three weeks; during which period the bowels should be confined for the first week, and the bladder emptied by using a catheter. In removing the sutures, the lower ones may be withdrawn after a week or ten days; the upper ones, where the tension is greater, not until a few days later,—say a fortnight. By this operation, a small pouch is left between the horns of the horseshoe above, through which mucus can escape, or the menstrual fluid be discharged from the uterus, but into which prolapsus is apt to recur if the interval be too large. Dr. Graily Hewitt's method proceeds upon the principle of constructing the *floor* of the vagina.

Tumours.—*Fibrous* tumour is not uncommon. It may occupy any portion of the uterus: embedded in the uterine wall,—intra-mural; projecting into the abdominal cavity,—sub-peritoneal; or pedunculated in the cavity of the uterus,—submucous; or even protruding into the vagina, as a fibrous polypus. The tumour is slow-growing, but may attain to a large size, weighing several pounds.

The first or intra-mural kind are often attended by pain, owing to the irritation of the uterine muscle, which contracting, tends to extrude the tumour. Thus, an intra-mural tumour may become sub-peritoneal. This form is the most innocuous, becoming greatly isolated from the uterus. It rarely causes hæmorrhage. It can commonly be felt and grasped by the hand through the abdominal wall. The process of extrusion may even go so far as to detach the tumour altogether. It then falls into the lowest part of the abdominal or pelvic cavity. The third kind, or submucous fibroid, is also the result of the process of extrusion. Projecting into the uterine cavity, it retains intimate relations with the uterine wall and the vascular system; and is especially apt to cause expulsive spasmodic pains and hæmorrhage. The fibroid polypus is a further step of the submucous tumour. Extrusion is so advanced that the connection with the uterus is only by a pedicle; and cases are not uncommon where the extrusion is complete, the pedicle is atrophied, and the polypus is cast out altogether.

The intra-mural and submucous forms are the most serious. They may endanger life—(1) by repeated hæmorrhages; (2) by pressure upon surrounding organs.

The age of production, or at least of discovery of uterine fibrous tumour, is usually between thirty and forty.

Treatment.—Removal of the tumour cannot be effected by absorption; and any medicinal treatment for this purpose, whether by the administration of iodine or mercury internally, or by the introduction of these agents into the vagina, will be of little or no avail.

On the other hand, the propriety of *operative* interference must be well considered.

The slight connection, vascular or fibrous, between an embedded fibrous tumour and the uterine substance, is a structural condition favourable to removal of the mass by "Enucleation." When also the tumour is pedunculated, and presents into the uterine or vaginal cavity, its removal can be accomplished by the wire écraseur. But the difficulty and danger of the former operation are serious considerations. The necessity for that procedure should, therefore, always be determined by the presence and urgency of symptoms. And the necessity thence arising will be absent, in proportion as the tumour is embedded, or projects into the abdomen.

Enucleation may have one of two objects in view: direct removal of the tumour at the time,—*primary* enucleation; or, the disturbance only of the relations of the tumour, so as to induce gangrene,—*secondary* enucleation.

Barnes ("Medical and Surgical Diseases of Women," 2nd ed., 1878) embodies the conclusions which his own experience and that of all recent operators indicate. "The justification for attempting enucleation, avulsion, or other mode of removing large fibroids will rest upon—(1) uncontrollable hæmorrhages endangering life; (2) signs of sloughing or decomposition of the tumour, with present or threatening peritonitis or pyæmia; (3) dangerous pressure upon the bladder or rectum; (4) such great size as to cause dangerous pressure upon the abdominal and thoracic viscera. In short, life must be unmistakably threatened. The same conditions threatening life, and removal by the vagina being precluded, may justify the last resource—ablation of the tumour and uterus *en masse* by abdominal section."

Means for controlling hæmorrhage or other urgent dangers failing, we have to consider the best mode of getting rid of the tumour altogether. This embraces the discussion of the various proceedings for promoting expulsion; for causing destruction and elimination by setting up inflammation or necrosis in the tumour; for ablation by enucleation, avulsion, ligature, knife, scissors, écraseur, cautery; and for removing the uterus itself, along with the tumours, by laparatomy.

The idea of enucleation seems to have been first clearly enunciated by Velpeau. It was practised by Amussat, and had some vogue afterwards. L. Boyer, A. Bérard, Maisonneuve, and Lisfranc practised it; but many disastrous issues brought it into discredit. It was revived by Simpson, but a full report of his experience has not been made known. Lately the operation has been rather freely repeated. It might be said that the success is in relation to the choice of the case and the skill of the operator, leaving a considerable margin for accidental circumstances.

Atlee expresses the latest views (1876). If the tumour project into the uterine cavity, it may be favourable for enucleation. The first step is to obtain free opening of the cervix uteri. This is effected by incisions made by Simpson's hysterotome. These should radiate, so as to avoid extreme length of any one cut. It was established by Baker Brown, Nélaton, and McClintock, that the cervical incision alone would frequently subdue the hæmorrhage; it often also lessens pain. This point gained, we may often wait for the progressive advance of the tumour towards detachment from the uterine wall and conversion into the polypoid form. At the proper moment for action, full dilatation of the cervix being attained, the tumour may be attacked in various ways:—(1.) If there is any approach to pedunculation, a wire-loop écraseur may be passed over the tumour, so as to get beyond the equator or greatest diameter. The loop, under the action of the screw, will adjust itself to the narrowest part, and shave it off from the uterus. (2.) If the tumour is sessile by a broad base, an incision may be made by knife through the capsule, and fairly into the substance of the tumour; and then enucleation may be completed by the fingers, and by traction with a strong vulsellum. (3.) Sessile tumours, semi-polypiform, if too large for an écraseur, may be drawn down by a vulsellum; and by a series of oblique incisions the tumour undergoes elongation, and thus may be brought through. This, the spiral elongation, as it is called, is often useful. (4.) The tumour may be attacked in its vitality first, and then removed by secondary enucleation. Pieces may be cut out of it, caustics inserted into it, or the actual cautery applied to it. Under one of these means, necrosis of the tumour is set up, which, extending throughout its substance, softens it, and weakens its attachments to the uterine bed. Then avulsion by the fingers and vulsellum may remove it altogether. Many cases thus healed have ended happily; and could we with certainty limit the necrotic process to the tumour, this method would have more extended application. The danger, however, of metritis and septicæmia is serious, and cannot always be averted. Whenever this method is pursued, quinine and ergot should be given to promote uterine contraction. This may help in expelling the tumour, and in guarding against septicæmia.

Normal Ovariotomy—"*Battye's Operation.*"—Seeing that the growth of fibroid tumours is influenced by the ovarian stimulus, Battye and other American physicians have excised the healthy ovaries, so as to remove the stimulus. The proceeding is not altogether without clinical recommendation. It is still *sub judice*.

UTERINE POLYPI.—Various kinds and shapes of polypoid growths are liable to spring from the walls of the uterine cavity. (*a*) A sessile soft growth of small size, containing one or more mucous cysts, which consist of enlarged uterine follicles and hypertrophied cellular texture. Occasionally, pedunculated cysts attached to the cervix uteri: (*b*) a pedunculated growth of small size,—from that of a bean to a nut, soft, vascular, and often multiple, consisting of pendulous mucous membrane, and analogous to nasal mucous polypus; (*c*) a growth of finer texture and larger size,—a nut to an egg, more or less pedunculated, and consisting of mucous membrane, with a large excess of cellular tissue; (*d*) a much firmer growth than any of the preceding, and usually of much larger size, pedunculated or sessile, its attachment usually uterine,—the common fibrous polypus; (*e*) recurring fibroid polypus; (*f*) malignant polypus.

Signs.—Hæmorrhage from the vagina is the most common symptom; occurring irregularly, sometimes copiously, and continuing for a long period, unrestrained by any ordinary treatment. The amount and frequency of the hæmorrhage often diminishes when the polypus escapes from the grasp of the cervix; and usually it lessens in proportion as the peduncle becomes longer and thinner. Continuous leucorrhœa in the intervals of hæmorrhage, if attended with expulsive pain, is presumptive evidence of polypus. Pain usually remits when the polypus is extruded from the uterine cavity into the vagina.

Diagnosis.—Severity of pain is tolerably characteristic of *malignant* polypoid growth, and hæmorrhage is usually more abundant. The period of life most liable to the *benign* forms of polypi is that of menstrual activity, rather than of very early or later life; but no age is exempt. Vaginal examination by the finger is usually conclusive. The small mucous polypi growing from the os uteri are felt as pea-like bodies rolling under the touch. The larger fibroid polypi are made out as firm rounded masses, more or less constricted by the ring of the cervix uteri; the sound or finger may penetrate beyond the mass and constriction, thus making out a uterine cavity. The case is thus distinguished from inversion of the uterus, which commonly presents a firm rounded mass projecting into the vagina like a polypus, but in which the finger or sound are arrested at the root of the tumour, that is, at the groove of reflection of the uterus and vagina. Inversion is further determined by passing a finger into the rectum and a sound into the bladder, and then, turning the point of the sound backwards, it is felt by the finger in the rectum *above* the tumour, where the uterus, if in normal position, would be. To obviate the risk of amputating an inverted uterus by mistake for a polypus, Dr. Barnes urges that anæsthesia should never be employed. The polypus is insensitive. Acute pain arising during the grip of the wire, gives presumptive evidence of inversion. He relates cases in point.

Treatment.—Benign polypi admit of removal, by scissors, torsion, ligature, or écraseur. The risk of hæmorrhage should mainly decide the selection of either method of operation. But when the peduncle is long and thin, the best plan is to snip it through with scissors, or twist it with forceps until it gives way. Ligature by whipcord passed through Gooch's double cannula was a method formerly in vogue. The peduncle, gradually strangled, sloughed through, and the polypus fell off. Foul discharges, metritis, and septicæmia occasionally followed. Barnes cites fatal examples. The method is now abandoned for the immediate removal by écraseur. The wire is the best. The écraseur should be slightly curved at the end where the loop comes through; this greatly facilitates the adjustment of the loop over the tumour. If the tumour is large, it is convenient to seize it first by a vulsellum, and draw it down before adjusting the wire loop. The vulsellum, keeping its hold, is then useful in extracting the tumour from the vagina. Little bleeding usually follows the operation, and no dressing is required. It is, however, useful to wash out the vagina by syringing daily for a few days. It is one of the most satisfactory of surgical operations.

Cancer of the Uterus.—All forms of cancer may affect the uterus; either primarily, as being the seat of the disease; or secondarily, by invasion from other organs. Thus, we recognize scirrhous, encephaloid, and rarely colloid cancer of the uterus; also epithelial cancer and the so-called cauliflower excrescence and sarcoma, which especially affects the body of the uterus. But it is only when seated in the os uteri, and at an early period of the disease, that uterine cancer is amenable to surgical treatment.

Signs.—Pain and hæmorrhage are accepted as characteristic. But the first thing that commonly attracts attention is hæmorrhage, often to the extent of flooding, either in the form of menorrhagia, or occurring after the climacteric. When the stage of ulceration is reached, discharges are continuous; blood, mucus, watery, stained with blood, of offensive odour, alternate. Pain is not common until the disease has made great progress, invading the neighbouring organs. Then signs of constitutional infection are developed.

Diagnosis.—The epithelial form—the most common—which begins in the cervix uteri, rapidly catches neighbouring tissues, and, matting all together, fixes the uterus, and brings it nearer the vulva. The finger thus readily strikes upon the irregular knobby margin of the os, and feels the brawny continuity with the inflated surrounding structures. It is distinguished from pelvic cellulitis, which also fixes the uterus, by the disease in cancer involving the cervix principally, whilst in pelvic cellulitis the disease is external to the cervix. In cancer also, slight touch by the finger commonly provokes bleeding. *À fortiori*, the speculum will do so. The tissues are so brittle and vascular that they bear no pressure or stretching. The speculum, therefore, is mischievous, and it gives no help to compensate.

Excision of cancerous ulcer of the os uteri was originally performed by Osiander of Göttingen, and subsequently by Lisfranc of Paris. No particular directions are necessary for its performance; the operation consisting in dilating the vagina with the duck-billed speculum, seizing and dragging down the os with forceps, and then excising the affected portion. Hæmorrhage must be restrained by the actual cautery, or by perchloride of iron. It will perhaps be desirable to retain hold of the stump by transfixing it with a wire, so that in the event of secondary hæmorrhage, the requisite applications can be made. The écraseur may be used instead of the knife, when the whole neck of the uterus is to be removed.

The *results* of this operation are uncertain, both as to its immediate risks, and the average duration of life in successful cases. It would appear to be generally a safe operation; only two deaths having occurred in ninety-seven cases by Lisfranc, and one only in Dr. Sim's fifty cases—say, two per cent. But, in the hands of others, death has not unfrequently happened from hæmorrhage, or from a peculiar collapse,—the "abdominal collapse" of Dr. Barnes. When not immediately fatal, the operation is productive of only temporary benefit,—the disease returning. It is now, however, agreed that the majority of Lisfranc's cases were not cancerous. Sim's cases also were mostly hypertrophy.

Cauterization will be preferable, when the disease extends too deeply for excision. For this purpose, the dried sulphate of zinc may be used, as recommended by Professor Simpson; and in the form of a powder introduced through a speculum, or as a pessary of ointment. Some carbonate of soda, in the form of a pessary, should also be applied, to neutralize the zinc, which is apt to run. The chloride of zinc, and potassa-fusa, are less convenient kinds of escharotics. Bromine has been enthusiastically extolled as a caustic for these cases. But some, at least, of the presumed cures are explained by error of diagnosis. The actual cautery, applied by red-hot iron, by galvanic action, or by Paquelin's apparatus, is the best of all local agents.

Cure, or at least a temporary alleviation of the symptoms, has sometimes been effected.

Excision of the *entire* uterus may be resorted to for the removal of tumours involving the whole organ. Extirpation has been performed *per vaginam* in a few cases. Thus, Dr. Blundell removed the uterus for cancer, and the woman, who was fifty years of age, recovered. But this operation is of too dangerous a character to be lightly entertained. Removal by the *abdominal section*, as in ovariotomy, seems to have been more successful. In twenty-four cases collected by Dr. Storer, of Boston,—the uterus having been extirpated for tumours, malignant or benign,—eighteen were fatal, but six recovered, or one in four. To Dr. Clay, of Manchester, the credit is due of having first performed this method of hysterotomy, in 1843; but, ten years later, Dr. Burnham, of Lowell, gained the first successful result.

Palliative treatment is alone available in cases unfitted for operation, owing to a more advanced extent of disease. Pain may be mitigated by opiates, hæmorrhage restrained by styptics, and fœtid discharge corrected by detergent injections of chlorinated solutions, or Condy's fluid.

Absence of the Uterus and Ovaries.—This congenital defect occasionally coexists with imperforate vagina; the external organs of generation, constituting the vulva, being present, and the breasts developed.

The *signs* of this defective condition are these:—The patient may have attained adult age without ever having menstruated, and then an examination is instituted. Simultaneous exploration with the finger in the vagina and rectum, will ascertain whether the uterus can be felt; and its absence is confirmed by introducing a catheter into the bladder, the finger still remaining in the rectum, to feel that these two organs are in contact, without the uterus intervening as in the natural arrangement of the parts. The point of the instrument can be felt thinly covered through the gut. Sexual desire usually exists in this abnormity. And it has happened that, by fruitless attempts at sexual intercourse, the urethral orifice has become dilated to such an extent as to admit the finger into the bladder. Coitus has even been effected into the expanded urethra, as if into the vagina; and thus the existence of the malformation has remained undiscovered. But it has been shown by Oldham and Routh that the dilatation of the urethra is occasionally a part of the original fault of development. The operation for making a vagina has been described under Atresia of Vagina.

(3.) The Ovaries.—Tumours, and Ovarian Dropsy.—Ovarian Tumours are of two kinds, *Solid* and *Cystic*.

Solid ovarian tumours may be either *Fibrous* or *Cancerous;* the latter is most frequently colloid, and of a cystic rather than of a solid character, rarely encephaloid.

Cystic ovarian tumours comprise: *simple* cysts, with fluid contents, and single or multiple; *proliferous* cysts, having colloid contents, or solid growths. These varieties of cysts are less often met with independently, but as associated in the same tumour; which thus presents the characters of a compound tumour. The activity of proliferous tendency is an indication of the affinity of the tumour to cancer growth.

Dermoid Cysts are not included in the above forms of ovarian disease. These peculiar cysts contain all the appendages of the skin: hair, teeth, etc., and fatty secretion. Both ovaries are equally liable to cystic disease. Of seventy-five cases collected by Dr. West—nineteen of his own cases, fifteen of Dr. R. Lee's, and forty-one of Scanzoni's—in about one-third both organs were affected. It is usually believed that the right ovary is more commonly affected than the left. Simple cysts not seldom form in the broad ligaments, quite apart from the ovaries.

Diagnosis.—Ovarian tumours must be distinguished from other abdominal tumours:—from the gravid uterus in pregnancy, tumours of the uterus, omental tumours; ascites, hydatids, dropsy of the Fallopian tubes; enlargements of the liver, kidney, spleen, and stomach; hysterical tympanitis, fæcal accumulations, and distension of the bladder; abdominal and pelvic abscesses, and as proceeding from spinal curvature. The utmost care and caution must be taken in the diagnosis, before laying open the abdominal cavity for the removal of a supposed ovarian tumour, and then only discovering its real nature.

Causes.—No *period of life* is free from the liability to ovarian disease. During the whole period of sexual activity, it is of tolerably frequent occurrence; but in the latter half, or from thirty to forty-five, it is most frequent. It is very rare in childhood; and decidedly uncommon after the complete cessation of menstruation. It is relatively more common in *single* than in married women; and of the latter, a large portion have been *sterile*, or not readily impregnated. Age and social condition afford little or no aid in the diagnosis of an abdominal tumour, as to its being ovarian. Sterility or feeble fecundity is an association of somewhat more significance, but the sexual functions may be quite healthy.

Rate of Growth.—Generally, in from *two* to *three* years from the commencement, or first discovery, of the tumour, it will have attained to such size as to occupy the abdomen, and produce various inconveniencies as the result of pressure on the viscera. Sometimes the growth is much more rapid, and occasionally, especially in the aged, it may be much slower.

The *natural course* of ovarian tumours subsequently is less certainly known, treatment usually having been resorted to when it has become a source of serious inconvenience. But in patients under forty years, ovarian dropsy, not interfered with, gradually undermines the general health; partly by functional derangements in consequence of unrelieved pressure, and partly by the demands of the tumour as a drain on the patient's strength. Thus, by pressure, the process of assimilation is interrupted; the circulation obstructed so that the legs become œdematous; the respiration embarrassed by upward displacement of the diaphragm and ribs. The patient can no longer rest in the recumbent posture, and, worn out by sleepless nights and protracted suffering, death ensues at the end of one or two years from the date of abdominal inconvenience. Sometimes, intercurrent attacks of peritonitis, or of one of the cysts in the tumour, carry off the sufferer before the period of what may be called her natural release.

Spontaneous cure has been known to occur; either by cessation of secretion and then progressive absorption; or by rupture of a single cyst into the peritoneal cavity, the intestine, or the vagina, and thence the subsidence of the tumour. But the former mode of cure is a very rare event; the latter has happened occasionally, yet always in a manner precarious or perilous. Barnes relates cases of spontaneous cure by perforation and discharge into the intestine.

Treatment.—No medicinal measures, internal or topical, have any influence in curing ovarian tumours. Surgical treatment comprises—(1) the Palliative operation of *Paracentesis* or tapping, repeatedly performed as occasion may require; (2) Tapping, with various measures for inducing *Obliteration* of the cyst; as by injection of tincture of iodine, or by mechanical compression, or by the attempt to establish fistulæ for drawing away the resecreted fluid; (3) *Extirpation*, or *Ovariotomy*.

(1.) *Tapping* is available only in Cystic tumour; where the cyst is single, or in multilocular tumours where one cyst greatly predominates in size. It affords temporary relief, but resecretion of the fluid rapidly takes place; and this entails a drain upon the patient's strength greater than would have occurred from continued secretion in a full cyst; it necessitates also a second tapping, and even many subsequent operations, each at progressively shorter intervals. The duration of life, under repeated tappings, is probably shorter than when the tumour is left to itself; death usually taking place in three or four years after the first operation. The immediate risk from tapping is not inconsiderable; rapid exhaustion, or fatal peritonitis, sometimes follows, and acute inflammation of the cyst occasionally. Puncture of an adherent coil of intestine must not be overlooked as a possible contingency. The *operation* is performed as for ascites, the point selected for puncture being one of absolute dulness; and this is usually in the middle line, a little below the umbilicus. Some other part of the abdominal wall may be more eligible, as in the linea semilunaris. A multilocular tumour can perhaps be partly emptied by introducing the trocar at different points, into its most prominent loculi.

(2.) *Obliteration of the Cyst.*—*Injection* of the tincture of iodine is an appropriate mode of effecting obliteration of an ovarian cystic tumour, when the cyst is single. But, in such case, the diagnosis from ascites must be very carefully ascertained; as the danger consequent on injecting the peritoneal cavity—the production of peritonitis—would be much greater than if ovariotomy were attempted by an error of diagnosis. Acute cyst-inflammation is another source of danger. If the tumour be multilocular, inflammation is very apt to follow in the uninjected cysts, in consequence of the adjoining source of irritation. Lastly, secondary cysts, which had been suppressed by the pressure and growth of a larger, predominating cyst, may subsequently become developed; thus converting an apparently unilocular cyst into a multilocular tumour, and rendering the operation abortive as a radical cure. The *operation* is performed by first tapping the tumour in the ordinary manner, and introducing a flexible catheter through the cannula to draw off as much fluid as can be obtained; then from four to six ounces of the tincture should be injected and retained, or after about a quarter of an hour allowed to drain out. A diluted solution of the iodine might be preferred, as was recommended by Boinet, who originated this method of treatment; but there will always be a certain quantity of fluid remaining in the cyst, sufficient to dilute the tincture. Inflammation of the cyst, with the effusion of plastic matter into the interior, soon follows the injection; and by this moderate degree of the process, a cure has been effected. But this plan is involved in so much uncertainty that it has been almost entirely abandoned.

After-treatment must be directed to regulate the inflammation; stimulants or opiates being given according to the symptoms.

Sometimes the constitutional disturbance is considerable; a severe febrile paroxysm supervening with intense iodism, and impregnation of the urine and saliva with iodine.

Compression, by means of a starch bandage applied to the abdomen, as a mode of inducing obliteration of the cyst after tapping, is a plan of treatment now generally acknowledged to be at least useless.

Fistulous channels have been formed artificially, communicating with the interior of the cyst, through the abdominal wall, or through the vagina or rectum, so as thus to drain away the fluid secreted; but this mode of obliteration also has fallen into almost entire disuse, as being more hazardous than ovariotomy. It is, moreover, a long, painful, and exhausting method; and the permanency of cure is very uncertain. This method would be applicable only where the tumour is unilocular.

(3.) Ovariotomy.—Extirpation of Ovarian tumours, cystic or solid, is an operation of comparatively recent date. Suggested by Dr. William Hunter, advocated by John Bell, and first practised by Dr. McDowell in 1809, the latter an American pupil of John Bell, Ovariotomy is therefore unquestionably an operation of British origin; and it is to the labours of British Surgeons that its subsequent progress is chiefly due. The woman first operated on recovered, and survived for many years. Mr. Lizars, of Edinburgh, attempted the first operation in Great Britain, in 1823; but the abdominal enlargement was found to be due only to obesity and tympanitis. The patient recovered. In London, the first attempt to perform ovariotomy was made by Dr. Granville, in 1827; the operation was abandoned on account of the extent of the adhesions. This patient also recovered. Both these operations had been done by the *long* incision, extending from the sternum to the pubes. The *short* incision, originally suggested by William Hunter, was first practised by Mr. Jeaffreson, of Framlingham, in 1836; the patient recovering, and afterwards bearing children.

The first *completed* operation in *London* was performed by Mr. Benjamin Philips, at the Marylebone Infirmary, in 1840; but the result was unsuccessful. The first *successful* case in the metropolis fell to the lot of Mr. Walne in 1842, followed by two other successful cases in 1843. At length, in 1846, Mr. Cæsar Hawkins performed the operation successfully at St. George's Hospital; this being the first successful case by a Surgeon of any of our Metropolitan Hospitals. Ovariotomy has been *established* as a recognized operation in Surgery, by the labours of Dr. Clay, of Manchester, who in 1842 commenced his series of cases; by Dr. Frederic Bird, who began in 1843; by Mr. Lane, in 1844; by Mr. Baker Brown, in 1852; and by Mr. Hutchinson, in 1858. Keith, Peaslee, and Atlee especially have added largely to the experience and authentic records of the operation. Mr. Spencer Wells commenced his long series of operations in 1857, and has performed Ovariotomy in more than 700 or 800 cases.

Conditions favourable and unfavourable for Ovariotomy, and the Selection of Cases.—The following general conclusions are gathered from Mr. Spencer Wells's report of his first and second hundred cases.

(1.) The probable result of Ovariotomy can be estimated with far greater accuracy by a knowledge of the general condition of the patient, than by the size and condition of the tumour. In other words, a large tumour, extensively adherent, in a patient whose heart and lungs and digestive and eliminative organs are healthy, and whose mind is well regulated, may be removed with a far greater probability of success, than a small unattached cyst from a patient anæmic, whose heart is feeble, whose assimilation and elimination are imperfect, or whose mind is too readily acted upon by either exciting or depressing causes. Hence, the explanation of a commonly received erroneous belief; that the more advanced the disease the greater, and the earlier the stage of the disease the less, is the probability of recovery. Keith prefers a patient who has been obviously worn by the disease.

(2.) Age.—Below the age of twenty, and between forty and fifty, the mortality is less than that between twenty and forty, or above fifty.

(3.) Social condition.—In Hospital cases, the mortality is about 30·4 per cent.; in Private cases, about 30·6 per cent.; or nearly identical.

(4.) Adhesions of the tumour.—Adhesions to the abdominal wall, omentum, or intestines appear to have little, if any, influence upon the mortality; so that the importance which has been attached to the diagnosis of these adhesions before operation has been very greatly and unnecessarily exaggerated. But adhesions within the pelvis, to the bladder or rectum, or around the brim of the pelvis, are very significant; as they may be inseparable without great and immediate danger to life, by injury to these organs, or to the iliac vessels of the ureters. Adhesions to the under surface of the liver or spleen are also of grave import. The diagnosis of *such* adhesions is of the utmost importance.

(5.) Size of the tumour has not, by itself, appeared to affect the result; but size and solidity together are important in so far as they affect the *length of incision* requisite for removal of the tumour. In 100 cases, it was necessary to carry the incision above the umbilicus in 20 patients. Of these, 9 died; a mortality of 45 per cent. In 80 cases, the incision did not extend above the umbilicus. Of these, 25 died; a mortality of 31 per cent., or 14 per cent. in favour of the short incision.

(6.) Influence of Tapping.—As affecting the operation of Ovariotomy, the prior performance of Tapping has certain relations which are indicated by Mr. Spencer Wells's *third* series of 100 cases:—That one or many tappings do not considerably increase the mortality of ovariotomy. That tapping may often be a useful prelude to the operation; either by giving time for the general health to improve, or by lessening the shock when the fluid is withdrawn a few days or hours before removing the more solid part of an ovarian tumour. That when the siphon-trocar is used in such a manner as to prevent the escape of ovarian fluid into the peritoneal cavity, and the entrance of air into the cyst, the danger of tapping is very small.

Operation.—The *Instruments* requisite for Ovariotomy are—scalpels, director, a large trocar and cannula, or two, and elastic tube, strong vulsellum-forceps, cautery-irons and clamp, whipcord ligatures, strong nævus-needles for carrying ligatures, stout and long hare-lip pins, and silver-wire sutures; Keith's drainage-tubes, strips of new flannel, and large fresh sponges, soaked in warm water. The room should be raised in temperature to 70° or 75° F.; and the patient remain if possible in the room after operation.

No special preparation of the patient is necessary; excepting that the bowels should have been opened by a gentle aperient of castor oil on the day previous to, and by an enema on the morning of, operation; and the patient should be in her usual health.

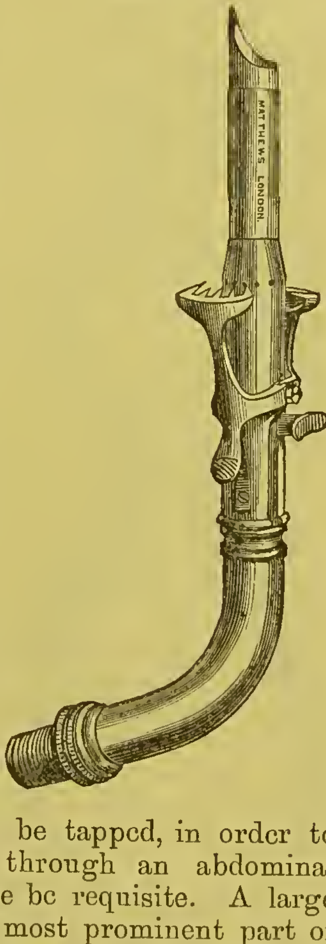
The application of Lister's antiseptic method to ovariotomy is warmly advocated by Keith, Barnes, and others. They entertain no doubt that it contributes to the success of the operation. It is not uncommon to find entire absence of suppuration in the wound or suture tracts.

Ovariotomy consists generally of the following seven steps or procedures in succession:—An incision in the middle line or linea alba between the umbilicus and pubes; introduction of the fingers or hand into the peritoneal cavity to gently explore the situation, nature, and extent of any adhesions, in order to determine the practicability of completing the operation; tapping the tumour, if cystic; cautious separation of any recent adhesions; securing the pedicle; separation of the tumour from its pedicle, and removal of the tumour; closure of the wound.

In carrying out these directions, certain *particulars* must be observed as essential to the probable success of the operation.

The patient clad in blankets, and ether having been administered, the bladder is emptied by a catheter. The Surgeon, standing on the patient's right side, makes an incision in the middle line or linea alba, commencing about two inches below the umbilicus and carried down to about four inches in length. The abdominal wall being divided by a few horizontal touches of the knife, the peritoneal cavity is laid open. Care must be taken not to mistake the peritoneal membrane for the cyst-wall, and thus proceed to detach that membrane from the fascia transversalis; an error which has happened several times. The peritoneum having been opened sufficiently to introduce the finger, it should be slightly raised from the cyst to make certain of this fact, and then laid open on the finger or on a broad director.

FIG. 967.*



A longer, or even a shorter, incision may be requisite, according to the size of the tumour, and the situation and extent of the adhesions. It is rarely necessary to have recourse to the long incision, extending from the sternum to the pubes. The wound may be extended upward or downward, as found desirable. This is best done by a strong pair of scissors, bent at a slight angle on the edge. The fingers or the hand are now introduced into the peritoneal cavity, and the existence of adhesions ascertained, their situation, nature, and extent. They may be such as to determine the propriety of not completing the operation; the abdominal section would then have to be closed. When, as usual, the operation is *proceeded* with, the tumour, if *cystic*, should be tapped, in order to more conveniently effect its removal, and through an abdominal aperture of smaller size than would otherwise be requisite. A large hollow trocar and cannula is thrust into the most prominent part of the tumour, and the fluid drawn off through the cannula. (Fig. 967.)

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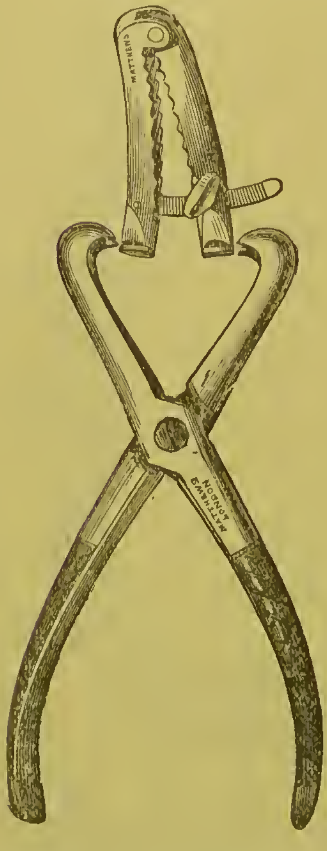
* Ovarian hollow trocar, with claws for fixing the tumour. (Spencer Wells.)

Especial care must be taken to prevent any of the ovarian fluid escaping into the abdominal cavity; and a long vulcanized india-rubber tube fitted to the cannula will be the best safeguard. A little alteration of the patient's position, on to her side, and some compression of the abdomen, may prove advantageous in emptying the cyst.

If there be no adhesions, the tumour is now seized with a strong vulsellum and easily drawn out, as a bag, through the abdominal aperture; an assistant or two at the same time following up and closing the wound around the pedicle, so as to prevent any escape of the intestines, by handling the wound with strips of flannel wrung out of warm water. If there be any *adhesions*, or the tumour be *solid*, the fingers or hand must be passed into the abdominal cavity; the same precaution being taken by the assistants during this manipulation. When the adhesions are slight and situated anteriorly, they are readily separated by passing the hand round the front part of the tumour. When they are firm, deep-seated, and extensive, the operation becomes proportionately difficult and perilous. Fortunately such adhesions are comparatively seldom found posteriorly, or connecting any of the abdominal viscera, except the uterus. These bands should be torn through, and very cautiously, not to injure the attached organ; their division with the knife being unsafe, on account of the liability to *hæmorrhage* from the vessels which commonly exist in firm, organized adhesions. If very vascular, they should be secured by fine catgut or silk sutures, and cut off on the cyst side; or, in extreme cases, a small screw-clamp is passed under them, and separation is then effected by the hot iron. Any risk of *laceration* of the attached *organ*, as intestine or liver, must, however, be especially avoided; and it will be more proper to cut across and leave the closely adherent portion of cyst-wall, than incur the danger of visceral rupture.

The *pedicle* protruding through the abdominal incision, as guarded by assistants, the Surgeon proceeds to secure it. This may be effected either by means of a clamp or by ligature. The former is especially applicable when the pedicle is long and narrow; and various modifications in the form of the instrument have been proposed by different ovariotomists, each rejoicing in the perfection of his own clamp. The first was introduced by Hutchinson. The form of clamp devised by Mr. Spencer Wells is now generally employed. The two blades, compressing the pedicle, are fixed by a screw (Fig. 968); and then the handles are detached, leaving a small, light instrument in connection with the wound. Ligature will be more appropriate when the pedicle is short and thick, whereby the clamp would be drawn inwards to the

FIG. 968.*



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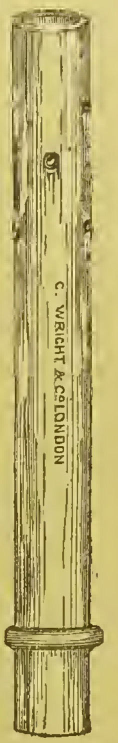
* Ovarian clamp, with clenching forceps. (Spencer Wells.)

pelvic cavity, or the uterus be drawn upwards forcibly towards the surface. The whipcord ligature seems to answer best, and it should be applied by transfixing the pedicle with a nævus-needle armed with the double ligature, and tying each portion securely. Care must be taken not to transfix any large artery or vein, the latter vessels particularly being large-sized and thin-walled. The pedicle is now to be divided, at a sufficient distance from the ligature, or beyond the clamp externally, to prevent any risk of its slipping through, and thence of subsequent hæmorrhage. The ovarian tumour is thus detached.

Drainage.—If irritating fluid has escaped into the peritoneal cavity, or suppuration exist, drainage may be useful. The best way is to insert one of Keith's glass tubes (Fig. 969); one end is passed into the bottom of Douglas's pouch, whilst about two inches is left projecting from the wound. It is secured there between the lower sutures. Over the open end of the tube a sponge is laid, surrounded by a bit of sheet india-rubber, to catch any fluid oozing up; and, daily, any collection in the pelvis may be pumped up by a syringe. But says Keith, "Since using the antiseptic method I drain almost never."

Fig. 969.



Closure of the wound concludes the operation. If the pedicle is ligatured, it is dropped back into the abdomen; if clamped, the clamp of course protrudes externally. Closure may be accomplished either with hare-lip pins and twisted suture, by interrupted silk sutures, or by wire sutures; and these are passed through the entire abdominal wall, including the peritoneum. They should be placed an inch from the edge of the incision, on either side, so as to have a firm grasp; and not more than three-quarters of an inch apart. The clamp is then to be padded with lint. The antiseptic dressing is then applied, supported by broad straps of plaster, and over all a four-tailed flannel binder. A warmed bed should be at hand for the reception of the patient, and any slight stimulant administered which occasion may require.

After-treatment is very important, and it comprises chiefly the following general directions. They have reference specially to the three sources of danger after ovariotomy: peritonitis, exhaustion, secondary hæmorrhage. To avoid any tendency to vomiting after the operation, nothing should be taken by the mouth during the first twelve hours, but a little ice, and no opium or other medicine. Milk or beef-tea should form the nourishment for several days; with wine or brandy as stimulants, and opium, according to the constitutional state of the patient. The nourishment may be administered by enemata, if the stomach continue irritable. No action of the bowels must be allowed, if possible, for a week, the influence of opium having the advantage also of checking intestinal action; and the urine should be drawn off by a catheter two or three times a day. *Peritonitis* must be treated on ordinary principles, as in connection with strangulated hernia. The management of the *wound* is simple. The portion of pedicle left external to the clamp may be cut off on the day following the operation, as there will then be no risk of slipping, and it is very desirable to avoid any source of decomposing matter. The clamp itself may be removed on the third or fourth day. The sutures should be left to the fifth or sixth day; and when they are removed, great care should be taken to support the abdomen and wound, by long and broad strips of plaster, and firm application of the flannel bandage.

The *results* of ovariotomy have been increasingly successful. Three recoveries, at least, to one death is a proportion which may fairly be expected in practised hands. Dr. Clay's table of cases, gathered from all sources, gives us 212 recoveries to 183 deaths. But this is greatly surpassed by the later results of Mr. Spencer Wells's 700 or 800 cases, by Keith's especially, and others.

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PRINTED AT THE CAXTON PRESS, BECCLES.

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